Chemical Age

POLAROGRAPHY IN INDUSTRY (page 721)

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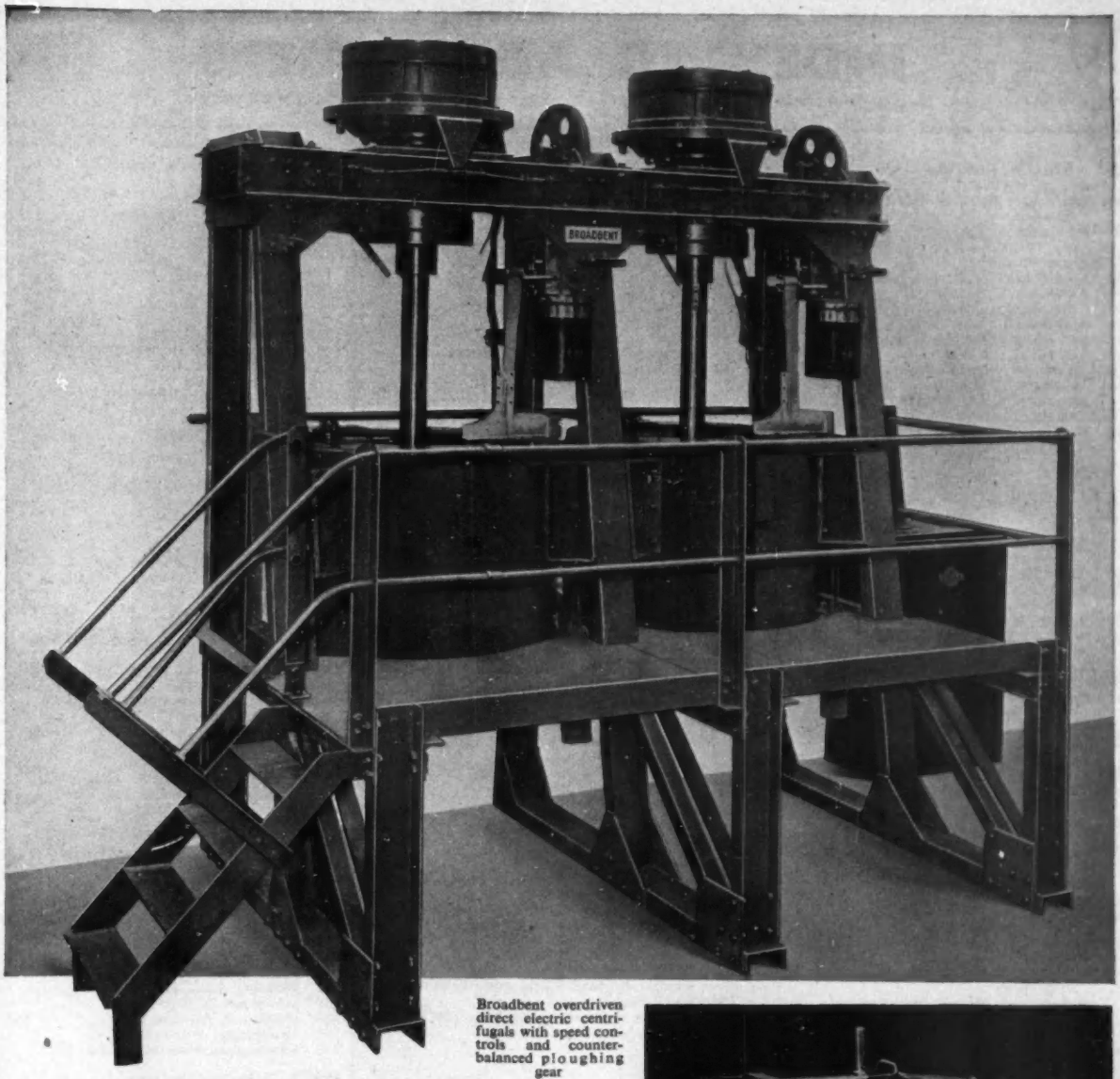

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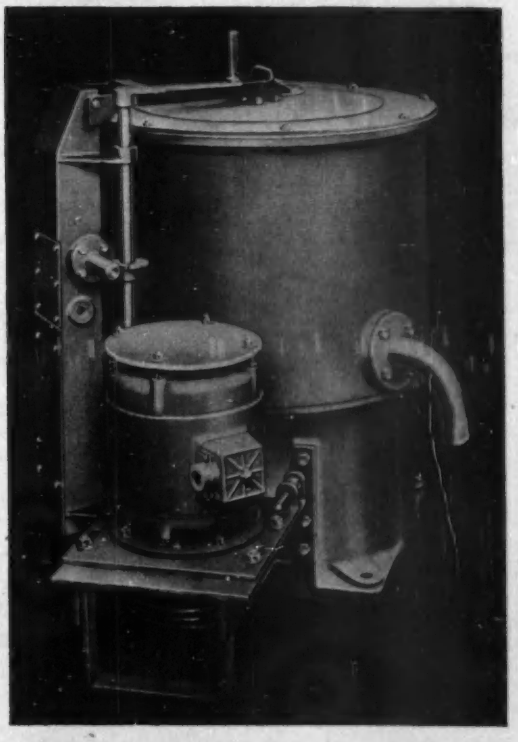

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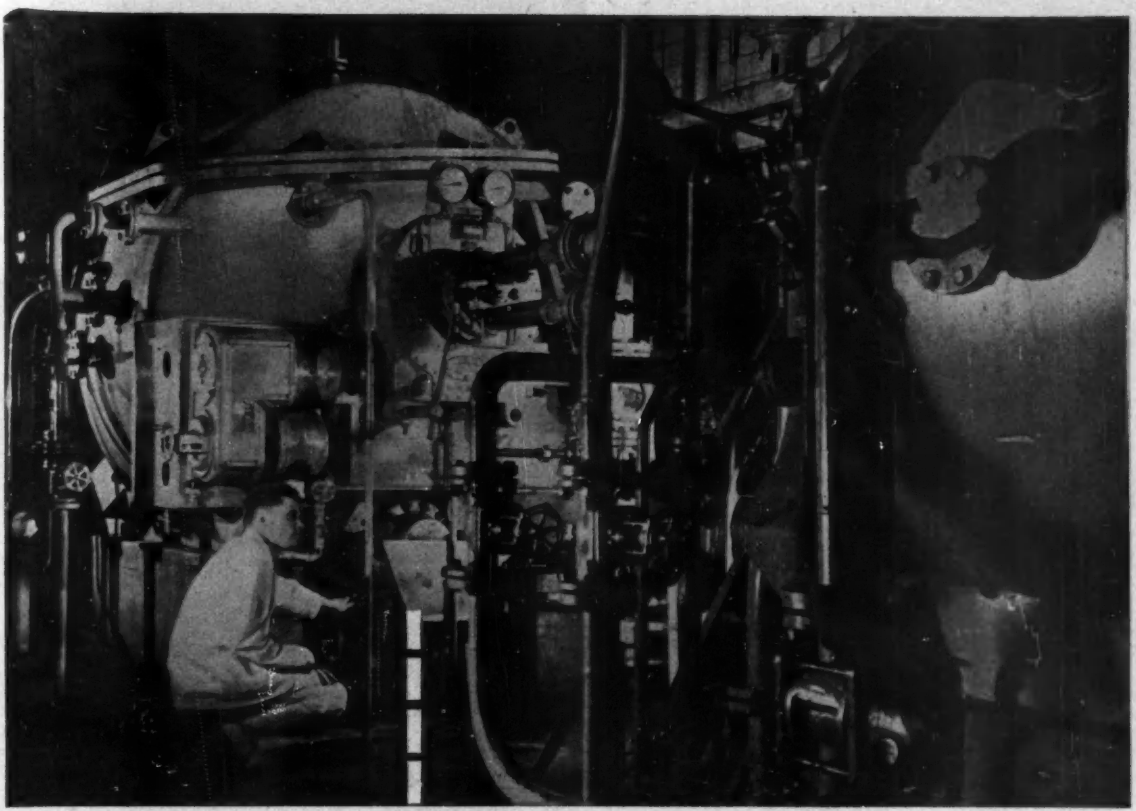

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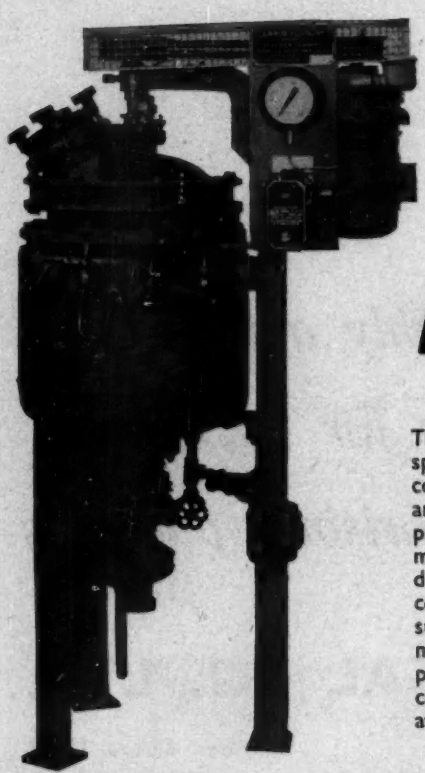

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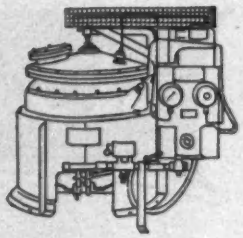

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CHEMICAL AGE

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PLANNING FOR EXPANSION

WITH the meeting of Ministers currently being held in Geneva and the conference on 'Preparing for the challenge of European free trade' held this week in the Festival Hall, London, by the Incorporated Sales Managers' Association, the concept of free trade in Europe remains in the news. Much has already been said on the subject and much remains to be said, but it would be as well to bear a few facts in mind when considering the project, if only to save time and effort.

It is unrealistic to discuss the project without taking into account certain facts. Firstly, the common market involving the economic integration of Belgium, France, Germany, Holland, Italy and Luxembourg is, since the signing of the Rome Treaty, a foregone conclusion. Agreement has been reached to reduce progressively tariffs and quota restrictions starting from 1 January 1959.

Secondly, it is now apparent that other West European countries will ally themselves to that common market, not to the extent of economic integration, but to a liberalisation of trade. The UK must take part in such a move, for while the idea of free trade within Europe is a risk to British industry, to remain outside would present an even more serious risk. There can be no doubt that to isolate British industry and commerce from trade with Europe is by far the greater risk. That being so the UK Government is quite right to take the lesser of the two risks.

But to dismiss the opening up of a new trading era in Europe as the 'lesser of two risks' is to do the whole project a great injustice. It cannot be denied that the opportunities for increased trade are immense. The UK exporter for instance is faced with what is in effect a mass home market of 250 million people. Competition both in the UK and on the Continent will be more severe than for nearly 30 years; that is the challenge that both Government and industry are accepting.

There, then, are the facts, over simplified, which form the background to any discussion of the European free trade project. UK industry can do itself no good by spending too much time arguing the merits of the scheme; it should accept it as inevitable and plan accordingly.

It has been said that the chemical industry stands to gain more than most other British industries from free trade in Europe. We firmly believe this to be the case. For one thing, the industry is an expansionist one; the opening up of a mass market will call for programmes of great expansion, using automatic methods to bring production up to the high levels that will be needed.

What is true of the chemical industry as a whole however will not necessarily be true of every company in the industry. Some companies make chemicals to sell on performance, aiming at the top of the market, others make for a price. While most chemical concerns are expansion-minded others, by nature of their trade, are restrictionist. So while the industry as a whole is likely to expand under the influence of a supermarket in Europe, some companies may well suffer, particularly those in the strategic sector, should the Government remove the Key Industry Duties. Future policy on protection for key industries has yet to be settled; it is by no means certain yet that special tariffs in these cases will completely disappear, for the protection of special industries is a problem that affects not only the UK.

But however they view the prospect of a European market, all chemical companies should now be actively planning for it. There is much to be done if the industry is to take advantage of the opportunities and to see that it is equipped to meet the more intense competition that will come.

On the sales side, companies should be considering the advantages or otherwise of opening sales offices on the Continent; methods of marketing; local demands; and aspects of market research, including what chemicals are likely to sell best and whether some lines should be dropped at the expense of others likely to do better under free trade.

So far as production is concerned, there are a number of points for study. Plans must be made now for a rationalisation of production, involving the stepping up of output of lines which it is decided to continue.

Further large scale investment is called for and there is no doubt that automation will play a large part in the plans of the chemical industry. Production ranges may well have to be standardised for the sake of efficiency.

This vital need for expanding productive capacity to make the most of the free trade opportunities and to withstand competition is likely to prove difficult. Most chemical companies will be only too happy to plan for an expansion of their sales organisations; but when it comes to investment, the majority are dependent on prevailing economic conditions, the directives of the Treasury and the attitude of the Capital Issues Committee.

Apart from considerations of ensuring fair and unsubsidised trade, the special approach to key industries and the problem of trades likely to be hard hit, the Government must pay immediate attention to the needs of those industries most likely to benefit from a West European free trade area. What is needed is an early indication of the Government's attitude to companies that wish to plan for expansion.

RUBBER-BASE PROPELLANT

ROCKETS fuelled by a rubber-based propellant may seem strange but it appears that Phillips Petroleum of the US already have a manufacturing process worked out. The processing of the rubber-base composite rocket propellant was described to engineers at a recent American Institute of Chemical Engineers' meeting in Baltimore.

This type of solid propellant is made up in two parts—binder and oxidiser. A still classified synthetic rubber is used as fuel and binder. The oxidiser is ammonium nitrate (fertiliser grade prills) which is crushed in a hammer mill to particle size 5 to 500 microns, since particle size is a controlling factor in burning rate. Also, as moisture is harmful in propellant storage, this is kept below 0.3 per cent for ammonium nitrate and the temperature maintained near 90°F. Other ingredients are carbon black (2 per cent) which reinforces the polymer, a plasticiser (2 per cent), curatives (0.4 per cent) to give the polymer the necessary physical properties and an age resister (0.3) used to protect the polymer from oxidation and other ageing effects.

The rubber is dried and broken down (to reduce viscosity and improve plasticity) in a heavy duty mixer. The other ingredients are then added. Then into the binder are incorporated the oxidiser (83 per cent of the final propellant) and a burning rate catalyst (about 2.3 per cent).

Mixing is continued to obtain good dispersion and can vary between 30 minutes and two hours. Temperature is kept at a maximum of 140°F. Part of the mixing is carried out under vacuum to remove air bubbles. The salt-loaded rubber is extruded by means of hydraulic extrusion presses. According to the Phillips investigator, C. F. Dougherty, die design is of importance to provide a propellant having a contoured approach section, polished surface and adequate land length.

To the non-burning surfaces of the propellant, pieces known as grains, a restrictor is applied composed of $\frac{1}{16}$ to $\frac{1}{8}$ in. sheet material similar to the binder with an adhesive where high velocity gas flows past joined surfaces. The grains are cured in an oven the temperature varying from 175° to 225°F and time from 16 to 48 hours, depending on the formulation and desired physical characteristics. The grain is then ready for insertion into rocket cases. About 10 per cent by weight of the final propellant is synthetic rubber.

POLYESTER RESINS IN CANADA

MORE than three million pounds of polyesters—excluding both polyester fibres and the alkyd resins—were consumed in Canada in 1956, principally in corrugated sheeting, boats and car parts. This poundage scarcely puts this thermosetting plastic within the range of the phenolics—not to mention the other well-known plastics, polyvinyl chloride, polythene and polystyrene. It does, however, represent a marked increase in the consumption drive. In 1951, Canada's polyester needs were all supplied with US imports. In 1955 Canadian industry had absorbed 2.5 million pounds of its own manufacture.

Initial producer of polyester resin in Canada was Naugatuck Chemicals. Recently this company announced its intention of spending half a million dollars by 1958 to extend its capacity at Elmira, Ontario, up to 6 million pounds per year. Continuous 24-hour production is to be maintained. The second company making polyesters is Chemical Oil and Resins, Toronto. A third manufacturer is now entering the field, Reichhold Chemicals, who have completed their polyester plant in Toronto.

Even with these companies producing polyesters, the US is still an exporter to Canada, as the Canadian tariff (5 per cent. *ad valorem* rate) is nullified by the premium on the Canadian dollar. Imports are stated to be of the fire-resistant type—hexachlorindomethylene phthalic anhydride, and chlorinated polyesters. With the exception of these last, Canadian resins can compete with the American counterparts. However, it should be remembered that both Naugatuck and Reichhold have US parents.

Nevertheless the present Canadian producers have been encouraged by the tariff to manufacture reinforced plastics, for on these, as reinforced parts, the US has to pay a 22 per cent duty and a 30 per cent duty on glass fibre.

No difficulties are encountered with regard to the supply of raw materials needed for polyester production. Phthalic anhydride is obtainable locally from Dominion Tar or Reichhold—or bought from Germany. Styrene monomer is sold by Dow and Monsanto and the glycols are obtained from Carbide Chemicals and Dow. Maleic anhydride has to be imported, however, from the large US producers, National Aniline, Reichhold or Monsanto.

It has been suggested that Naugatuck and Reichhold are likely to extend their production by producing alkyd-based polyurethane foams. The US parent companies of these two are both producing polyurethane foams, and the Canadian offshoots have carried out market surveys. The Canadian market appears to be limited for this product. Also there is the possibility that this semi-rigid material will be outdated by polyether-based urethane.

Authorities in Canada consider that the three present producers will concentrate on enlarging their present ranges of resins by blending, changing of ingredients to give fire-resistance or other desired properties and to adding plasticisers and fillers to suit a special application.

COAL AND COAL CHEMICALS

Dr. Bronowski Gives Tenth Dalton Lecture

L. to R. Dr. V. Bowden, principal, Manchester College of Science and Technology; Dr. Bronowski; the Lord Mayor of Manchester; Prof. R. C. W. Norrish, vice-president, R.I.C., and Dr. S. J. Fletcher, chairman, Manchester section, R.I.C.

COAL had played a double part in the development of industry. It had provided the main source of energy, and it had also provided (as coke) the most important chemical raw material. In both uses, the demand had gone on growing fast since the second world war.

This was the comment made by Dr. J. Bronowski, when giving the tenth Dalton Lecture in Manchester on 25 October, on the subject of 'Coal and coal chemicals in the national economy.'

In 1946, just over 25 million tons of coal went to electricity generating stations in the UK; in 1956, it was over 45 million tons. As for coke, about 8½ million tons of it went into blast furnaces in 1946; in 1956 it was just over 13½ million tons.

The fact that coal that was being mined contained more volatile matter year by year might actually add to its usefulness as a chemical, stated Dr. Bronowski, because there was a higher ratio of hydrogen to carbon in such coals—and therefore, potentially, a higher proportion of liquid and gaseous components.

Impressive List

The list of chemicals derived from the coke oven and the gasworks was long, and looked impressive. In fact, however, only a few of these had found a use in large quantities. There were three main groups of these: the chemicals based on benzene, those based on naphthalene, and those based on phenols. In addition, about one million tons of ammonium sulphate were made yearly; but this chemical was really a by-product of the process of cleaning gas, rather than a true product of coal.

If these were to continue to be the main chemical uses of coal, then their expansion would depend on an increase in the output of coke, and this in turn would largely depend on an increase in the output of pig iron.

Discussing the quantities of chemicals which could be produced on present-day estimates up to 1975, these did not offer in themselves much comfort, because, first, they required from the coal industry in 20 years an additional yearly output of nearly 25 million tons of coking coal; and coking coal, while adequate, was by no means plentiful in Great Britain and was more costly to mine than the more plentiful coals with higher volatile content. Second, they required the building up of a great number of new coke ovens. Moreover, if this expansion were achieved by the traditional method of making coke and using it to make pig iron, the coal industry would still be left with the coals with higher volatile contents which did not make coke.

It would not be enough to make chemicals only from the gas and tar which were given off at coke ovens. A farsighted policy for the future of coal must take a more definite course. It must consider what basic chemicals the expansion of British industry would require, and then ask in what way these could be made economically from the main British chemical raw materials—above all, from coal.

Before the war, in Britain, the chemical industry accounted for about 2 per cent of the total national production. This figure had risen 3½ per cent in 1955; and in that year, chemicals accounted for no less than 8 per cent of our exports—i.e. £250 million of exports.

Data given by OEEC in 1956 showed that the rate of expansion of the chemical industry since the war had in fact been similar in Great Britain and in the US and it was, therefore, reasonable to translate the forecasts of the Paley report into forecasts for Great Britain. However, no allowance had been made for new discoveries which might transform the chemical industry, nor for possible market changes, for example, within the Commonwealth.

One could say with confidence that the range of new materials would be expanded; there were already new uses for the polyester resins, and important new synthetic materials were appearing, for example, as rubber substitutes.

Discussing the coal molecule, with an essentially closed structure, and the open structure of the petroleum molecule, Dr. Bronowski said that if it was desired to build a chemical up from small open pieces, then petroleum was the obvious starting point; to break open the closed hexagons of coal was a more difficult business, which required a greater input of heat energy and the product of the breakage was likely to be a rather irregular mixture. For a chemical which contained closed rings—i.e. an aromatic—then coal was the more sensible starting point. (i.e. for benzene and napthalene.)

Thus, for the main range of chemicals, which were not aromatic, a way had to be found of breaking open the carbon hexagons in coal, which did not use uneconomic amounts of heat energy. Moreover, these small building blocks for the large chemical product needed to have a higher proportion of hydrogen to carbon than the coal molecule had as a whole.

These two conditions were most easily met by splitting coal into two parts—one predominantly carbon and the other predominantly hydrocarbons and other volatiles. The traditional coking process did this, but it was not the only way and it could not treat the coals with which they were particularly concerned. The most attractive technique for a wide range of coals, Dr. Bronowski said, was the fluid bed. Such a fluid bed gave high rates of heat transfer, a uniform temperature throughout the bed, and a rate of reaction measured in minutes rather than hours. It also allowed the material to be handled as if it were indeed a fluid.

Treatment of coal with hot air, with steam, or with other gases, was now passing from the stage of research to that of development. It gave good yields of rich gas and very good yields of tar, and the powdered char which was left behind might have wide uses in the sintering of iron ore, as an additive to coking coals, and as a basis for smokeless fuels.

Present drawback to the treatment of coal in a fluid bed at medium temperatures of 400°C to 800°C was that the tars which were made, were less familiar than those which were made traditionally in the coke oven and the gas works. These tars, therefore, were less acceptable to the market to-day. But they could be used, for example, as constituents in a liquid coal tar fuel, for which the market was expanding rapidly, and was likely to outstrip the supply of conventional tars.

Whatever the particular use of the tar—and this was a problem which still needed much research—the char and gas had their immediate uses. The main objective at the moment was to use the char to make smokeless fuels.

The fluid bed gave promise of being

the cheapest method of removing smoke from coal and it recovered the smoke in a form in which it could be used as gas and liquid. The char was a kind of coke and an unpromising material for briquetting—particularly as any binder used must not in itself add smoke. They had succeeded in this work on the laboratory scale and were now moving forward to a large pilot plant. The next step was to use the same process to make the liquid fuels for which the demand was rising—gas and oil. In the long run the gas would be used as a synthetic gas, and so would become the basis of a liquid fuel and chemical industry.

Treatment in the fluid bed would propose to make gas in two stages and it may be asked what is the advantage of this. The advantage related to the modern needs, which were for more heavy oils, and for fewer light products, such as motor spirit.

The Fischer-Tropsch process for making oil from coal, invented earlier in the century, was directed to making motor spirit. The two-stage process of making char in the fluid bed, and then converting the char to synthesis gas, would yield 15 to 20 per cent more liquid products overall; and the increase would be in the medium and heavy oils.

Moreover the gas which came off directly from the fluid bed had a high calorific value of about 700 B.Th.U/cu. ft. This first-stage gas was therefore more flexible, in a variety of uses, than the average gas made in a single stage of total gasification, which had a calorific value of only 100 to 300 B.Th.U/cu. ft.

'In my view, this scheme makes it possible to be optimistic about the prospect of basing an oil and chemical industry on coal as a raw material,' said Dr. Bronowski.

'It may seem odd to hold out this long term prospect, that chemicals should be made from coal not directly but as part of the making of petroleum and other liquid fuels, yet this is what has been found—that all foreseeable ways of breaking the coal molecule so far lead back to the same point; in some way to use the breakdown to make a petroleum-like fluid, and to reach the making of chemicals by way of this.'

Three arguments in favour of this procedure were suggested by Dr. Bronowski: first, in the making of chemicals from petroleum, the basic building stones (in addition to carbon monoxide and hydrogen) were ethylene, propylene and butylene. The most likely way to do this in the near future was by way of the Fischer-Tropsch process for synthesising liquid fuels. Secondly, a process of synthesis such as the Fischer-Tropsch process, which was very flexible, gave through all its permutations a yield of one product with an assured market—a yield of petroleum oils. Third, no chemical industry could in a foreseeable time, absorb many millions of tons of coal. If many millions of tons were to be set free from the crude use in industrial power, then there was only one destination for them. They must be turned into liquid fuel.

Looking to 'the distant future' to the year 2,000, the most obvious answer was the treatment of coal with a cheap hydrogen. And looking into the remote future, then they might hope to reap from coal the major benefit which the use of nuclear fuel promised—a massive supply of cheap electric power. If electric power became very cheap it might in the long run become economic to make both hydrogen and oxygen from the electrolysis of water—oxygen for a number of processes (including the making of synthetic gas) and hydrogen for the hydrogenation of coal and other materials.

A 'different route' to making a wide range of chemicals from coal, which also seemed important in the long run, was to base a chemical industry on acetylene, which would be made from calcium carbide.

Dr. Bronowski emphasised that the views he expressed were personal.

Fischer-Tropsch Process Outlined at Dalton Exhibition

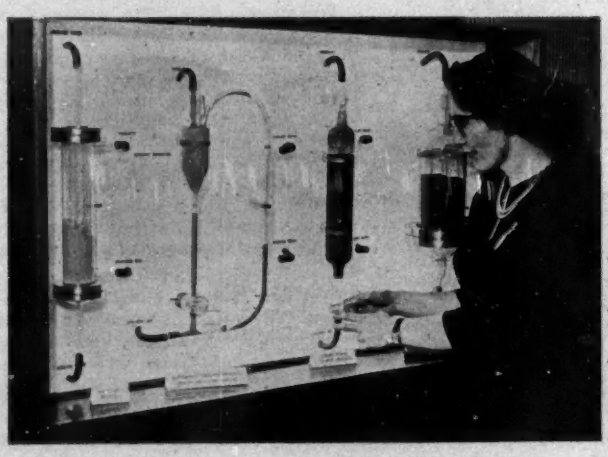
IN association with the tenth Dalton Lecture in Manchester on 25 October, an exhibition was held at the Central Library, Manchester, from the 21 to 26 October.

One of the exhibits demonstrated the production of smokeless briquettes; the model indicated a fluidised-bed carboniser followed by hot briquetting of the char, with a third stage of sand carbonisation of the briquette. The principle may be applied both to continuous operation or to a batch process. Several of these processes could be combined to form a single integrated unit.

There was included in the exhibits, details of the Fischer-Tropsch process in which synthesis gas is converted to fuel oils and chemicals. The basic principle of the process is that the molecules of hydrogen and carbon monoxide react in the presence of a catalyst to form chains of carbon and hydrogen atoms, sometimes with the addition of oxygen. The reaction must be carried out at a comparatively low temperature, and, since heat is generated by the reaction, the main problem of design is the removal of heat from the reaction zone.

The methods adopted for this removal of heat were shown in the models of four types of reaction vessel. In these (1) the catalyst is static and water-cooled; (2) the catalyst and reaction products are made into a slurry, through which the synthesis gas is blown, with cooling coils to remove the heat; (3) the catalyst is agitated, in the form of a fluidised bed, without carry-over of the catalyst; (4) the catalyst is entrained with the gas and recirculated. The products vary slightly, with the type of reactor used, but in general they are long-chain products of paraffinic type and alcohols and esters, etc., with some yield of waxes. Examples of products from the Fischer-Tropsch process were shown.

Nylon fabrics, which have a base of coal, and also the production of pigments used in the paints and dyestuffs industry, were also illustrated.



Miss Alison Martin, Coal Research Establishment, Cheltenham, demonstrates the Fischer-Tropsch process at the Dalton Exhibition in Manchester

Too Much Duplication in Scientific Instruments

DUPLICATION of effort in the UK scientific instrument industry was criticised by Mr. Paul Goudine (managing director, Electronic Instruments Ltd.), president of the Scientific Instrument Manufacturers' Association, at the annual convention in Eastbourne. The convention, attended by a record number of 249 members, ended on 27 October.

Mr. Goudine said there were too many examples of half-a-dozen companies making small quantities of virtually identical instruments. The industry must stop being parochial and get together with the aim of tackling the single task of the European free trade area.

The benefits of a free trade area were stressed by Mr. E. L. Bailey (managing director, Baird and Tatlock (London) Ltd.), and a past president. He stated that the industry was not afraid of the setting up of the area. While the UK scientific instrument industry would lose the sheet anchor of key industry protection, free trade in Europe would offer tremendous opportunities to expand the market for the sale of the industry's products.

If this opportunity was to be seized however, the free trade area must be regarded by British manufacturers as their home market.

BIOCHEMICAL RESEARCH FOR INSECT CONTROL

London Section RIC Meetings

IN research relating to the control of insect pests the biochemist is faced with the two main tasks of developing selective insecticides and of solving the problem of insecticide resistance. Ideally, a chemical substance is sought which is highly toxic to the insect pest but is innocuous to other forms of life. This ideal has not been realised, and, in general, insecticides are toxic to both insect and mammal, but under the conditions of application the concentration of insecticide absorbed by an exposed mammal is insignificantly small. Such were the opening remarks of Mr. F. P. W. Winteringham at the London Section, Royal Institute of Chemistry joint meeting with the College Chemical Society held at Brighton Technical College on 10 October. Dr. C. C. Hall took the chair.

Nevertheless, said Mr. Winteringham, precedents in other fields offer encouragement to those working towards this ideal and he instanced selectivity in the action of sulphonamide drugs and penicillium antibiotics, and the application of plant hormones for the selective destruction of weeds. An appreciation of the nature of the metabolic processes of the insect is, however, important. Any significant difference might then be exploited to the detriment of the insect pest. The advent of modern analytical techniques has paved the way for intensive investigations on insect metabolism. Especially spectacular are the experimental procedures combining partition chromatography on paper and radioactive labelling with, say, ^{32}P and ^{14}C. These processes have enabled the biochemist to detect and estimate the products of metabolism in a mere fraction of tissue extracted from a single insect.

One important distinction related to insecticide application is the greater permeability of the insect cuticle; insecticide applied topically is absorbed almost as completely as by direct injection. The larger surface/weight ratio of insects is a further factor favourable to insect control. Insect blood is very rich in amino-acids but the significance of this is not yet fully understood. Differences in enzyme sensitivity to insecticides or the existence of enzymes not present in the mammalian system may afford a promising field for investigation.

The development of insecticide resistance is threatening to jeopardise the benefits that have resulted from the widespread use of insecticides. Laboratory work on DDT-resistant insects reveals that they have acquired an ability to dehydrohalogenate DDT to a non-toxic olefinic compound. Attempts to exploit this characteristic by application of a phosphorus compound which dehydrochlorinates to a more toxic olefinic derivative have met with only partial success.

Small-Scale Testing for Brewery

ONE of the great difficulties in the investigation of brewing was the controlled use of small-scale tests that really adequately reproduce the full-scale processes of the brewery and its ancillaries, remarked Dr. A. H. Cook, of the Brewing Industries Research Foundation, at a meeting of the London Section, Royal Institute of Chemistry, held at Ewell Technical College on 14 October when the chairman was Dr. C. C. Hall. The whole brewing process is, however, carried out at BIRF under completely replicable conditions in a 'model brewery' working on a 10-gallon scale, all units being duplicated to allow a control 'run'. The barley itself is not handled from the start to the end of the process, and malting can be adequately investigated on a scale much smaller than formerly thought possible. A very versatile bottling plant enables beer to be filled into bottles of a wide range of sizes under any required atmosphere.

Reference was made by the lecturer to one of the great puzzles of malting, that is, the phenomenon of 'dormancy', when certain samples of barley refuse to sprout unless stored for a period of months after harvesting. This can often be avoided by steeping the barley in water containing small quantities of hydrogen sulphide or giberellic acid, the two together having a synergistic effect. In another type of dormancy the barley will only sprout if it is taken out of the steep when its moisture content is still below that required for complete growth so that the early stages of germination are able to proceed in absence of excess moisture. Loss in weight of the barley due to the metabolic processes during sprouting can be considerably reduced by removing the embryos after three days and allowing the barley to 'lie' for the remainder of the normal sprouting period before kilning, which allows the development of diastatic activity with much less disappearance of barley solids. New processes based on these findings promise to be of considerable commercial value.

The normal batch-wise 'mashing' process of the brewery can now, it is thought, be replaced by a continuous process with a great saving in space and capital cost of equipment. Elucidation of the true chemical structure of the compounds present in hop resins has largely accounted for the variations in the bittering power of different varieties of hops, which can now be evaluated by chemical analysis from this aspect. Application of vapour-phase chromatography to the volatile oil of hops has enabled their aromas to be 'fingerprinted' and a number of the compounds present in this portion to be identified. The 'fining' properties of yeast depend upon the magnitude of the electric charge on the cell wall, uncharged yeast cells not being brought down when isinglass finings are added to beer, while those with a high negative charge come out quickly. The higher the phosphorus content of the cell wall, the higher the negative charge on the cell.

Institute Formed for Polarographic Research

THE formation of the British Polarographic Research Institute has been announced. It is hoped that this Institute will eventually provide a comprehensive research, development and advisory service for polarographers and others with problems which may be solved by polarographic methods.

Many specialists in the various branches of polarography have offered their services in an honorary capacity to form a technical advisory panel. A council consisting of representatives of organisations contributing financially or otherwise towards the development of the Institute will advise on general policy matters.

In addition to contributions of laboratory furniture and chemical equipment, offers of operational assistance have also been received. Industrial organisations have offered facilities for the performance of tests on cathode ray and square wave polarographs. Electrochemical Laboratories have offered the Institute a manual polarograph. Professor G. Semerano, director, the Polarographic Centre, Italy, has presented a complete set of polarographic bibliographies and annual reports.

It is hoped that operating costs will be met by donations from individuals and organisations interested in furthering the Institute's activities.

Temporary accommodation has been found at 55 Oriental Road, Woking, Surrey, and the secretary of the Polarographic Society, Mr. W. J. Parker, will act as honorary secretary. Comprehensive services are expected to be available early in 1958.

ICI to Standardise on Unified Screw Threads

THOSE manufacturing divisions of Imperial Chemical Industries Ltd. which have not already done so are to standardise on unified screw threads and unified bolts and nuts in place of the present Whitworth Standards. The adoption of the new standard, which provides for diameters $\frac{1}{4}$ in. and larger, has already been announced within the company and will be made known to suppliers as occasion demands.

ICI will require all equipment which formerly would have been provided with Whitworth BSW, BSF or Whit. S threads to have Unified UNC, UNF or UNS threads. Other kinds of threads used by the company will remain standard; these are BA threads, pipe threads and other special purpose threads such as Acme, square and buttress threads.

Unified bolts and nuts are to conform with the precision normal series in the size range $\frac{1}{4}$ in. to $\frac{7}{16}$ in. inclusive and with the black heavy series in the larger sizes.

It is expected that the change will take several years, progressing at a rate governed by equipment changes.

★ THE NUMBER of full-time students at the Imperial College of Science and Technology has risen by 235 since last year and now stands at 2,450. Since the expansion programme was started in 1953, the student population has risen by 800. This was stated by Dr. R. P. Linstead, rector, at the commemoration day ceremony held in the Royal Albert Hall on 24 October.

No less than 15 new professorships and readerships in the University of London have been established and filled at the College in the past year.

The commemoration day address, marking the jubilee year of the College's charter, was given by Sir Alexander Fleck, chairman of ICI Ltd. Sir Alexander said that while the need for pure scientists continued unabated, the shortage of technologists, of practical men with a sound knowledge of scientific principles, offered perhaps a greater problem.

★ PROOF of the power of TV came last week after the BBC TV in their Panorama programme had made some scathing remarks about the apathy of engineering industries for their lack of support to the Production Engineering Research Association. In this week's Panorama, it was stated that since the previous programme, hundreds of enquiries had reached PERA from firms who wanted help in stepping up their productivity.

So research gets a free fillip from the BBC! I imagine that many other research organisations will now be pressing their claims for visits from BBC TV cameras.

★ A LEADING expert in the de-salting of brackish water, Dr. O. B. Volckman, head of a division of the South African Council for Scientific and Industrial Research is on his way to the US. He is to attend the first international symposium on saline water conversion, and present a paper on ion-selective membrane research and electrodialysis engineering in South Africa. The US and Holland are particularly interested in his work; there are vast areas of semi-desert in America that would derive great benefits if their salty springs were made sweet, and land reclaimed from the sea in Holland must wait a long time before it can be farmed.

The success of Dr. Volckman and his research team is reflected in the erection of the world's largest water-desalting plant at a South African goldfield, which when completed will be able to sweeten 3,000,000 gall. of brackish water a day.

A similar process is being developed in this country by William Boby and Co. Ltd. (See CHEMICAL AGE, 14 September, p. 405). The investigations of Dr. Volckman and those of William Boby follow similar lines, and information between them, particularly in the composition of the membranes used in the process, is being exchanged.

★ ONE of the most pertinent questions at the one-day conference on 'Preparing for the challenge of European free trade' held in London on Monday came from Mr. P. J. Scratchley, sales manager of the alloys division of Union Carbide Ltd. Mr. Scratchley wanted to know about the future of Key Industry Duties if the free trade project came into being. Were they, he asked, considered a normal tariff? Mr. Maudling, Paymaster General, said they were. He added that special consideration would have to be given to products of a strategic nature. The matter would have to be discussed between the nations.

Mr. Scratchley also wanted to know what action would be taken to prevent the French from subsidising exports through their social charges. Mr. Maudling clearly did not like the idea of exporters receiving subsidies by virtue of exemption from social taxes. He said that the whole question of export subsidies formed one of the most important features of the negotiations.

The conference, organised by the Incorporated Sales Managers Association, attracted an attendance of 1,450.

★ I WELL recall having seen a few years ago square holes being bored in Sheffield, but the news received from New York that Mr. P. Senio, a General Electric scientist, claimed to have made the first observation in nature of square bubbles was much more of a surprise. Senio reports that brilliant microscopic square and rectangular bubbles appear in lithium fluoride crystals, after irradiation with neutrons in a reactor and then heated above 600°C (1,112°F).

Senio says that square bubbles have never been seen in any other material and that no bubbles of any kind were found in lithium fluoride that was not first irradiated. During his studies he found that lithium bubbles appear first in bright colours and that these colours show that the bubbles have a third dimension even though they are extremely thin, measuring only about 3/100,000th in.

As the melting point of lithium fluoride, 842°C (1,547°F), is approached, the bubbles grow and combine to form new shapes that resemble sausages, boomerangs and other familiar objects. Their ultimate form during heating near the melting point of the crystals appears to be spherical as would be expected. Senio believes that formation of helium and tritium gases in the irradiated lithium is responsible for the bubbles, but can offer no explanation why they should be square and rectangular rather than spherical.

★ A RECENT statement on the part of the Minister in Charge of Australia's Commonwealth Scientific and Industrial Research Organisation that Australia was responsible for 95 per cent of all research into wool problems, has led to a rejoinder from Dr. A. B. D. Cassie, director of research of the Wool Industries Research Association at Leeds.

Writing in *The Times* on Monday, Dr. Cassie said that the CSIRO report for 1955/56 gave the income used for wool textile research as £A334,095. In the same year, the income of the WIRA was £235,039. Wool textile research began in Australia in 1946, more than 26 years after it had begun in Britain.

The textile department of Leeds University is also 'a very large contributor' to wool research, and in addition other technical colleges and many firms are active in this field. Dr. Cassie added 'Such information makes Australia's claim to 95 per cent of all research into wool problems somewhat difficult to understand. Research into wool is world-wide and although we welcome the co-operation of the CSIRO, I must state that WIRA has led the way for 39 years and continues in the forefront of this research'.

★ LATEST 'recruit' to the staff of Monsanto Chemicals Ltd. is an electronic digital computor weighing three tons. This is stated in the November edition of *Autoclave*, the company's house magazine, which now appears in newspaper format for the first time. A lift had to be built up the rear wall of Monsanto House and part of the fourth floor wall removed to allow the parts to be brought in.

The computor will initially produce the weekly London payroll and the monthly income statement for management. Later it will probably be used on financial accounting and statistics, cost report preparations and calculation, preparation of budgets and budgetary control and comparisons with actual performance.

This new version of *Autoclave* also reports progress at the new Fawley factory, expected to start production of polythene in 1959. Earth moving began in June and the stores, the first building, is now nearing completion.

Alembic

ROCKET AND MISSILE PROPELLANTS IN THE US

Fluorine's Future as a Rocket Chemical

SUBJECT of the spring meeting of the Commercial Chemical Development Association at French Lick, Indiana, US, this year was rockets and missile propellants. For this meeting, the US Assistant Secretary of Defence co-operated in the planning and certain information was specifically declassified. The meeting was designed to build up a background in the field, since it was felt that this was needed so that the propellant phase of the US missile and rocket programme, which would have the most significant effects on the US chemical industry, could be more intelligently interpreted, as information on the US programme is declassified and appears in lay and trade press. The papers are published in full in *Industrial and Engineering Chemistry*, 1957, **49**, No. 9 (September), pp. 1331-1348.

From its position in the periodic classification of elements, it is clear that fluorine and its derivatives should be among the most powerful oxidisers for use with the appropriate fuels to propel rockets. Mr. John F. Gall, (Research and Development Corporation, US) discussing 'Fluorine derived chemicals as liquid propellants' said that in addition to fluorine itself, such compounds as the halogen fluorides, nitrogen trifluoride, and oxygen difluoride should be considered.

Superior Performance

Fluorine, with an appropriate fuel like hydrazine or ammonia, is very substantially superior in performance to currently used oxygen and nitric acid oxidisers and would be equalled only by some fuel combinations with ozone.

It is pointed out that as fluorine is not an inexpensive oxidiser it might seem wrong to use it to burn low-cost fuel such as hydrazine. But in some circumstances this may be desirable. The major energy release from combustion of fluorine and hydrocarbon lies in the formation of the hydrogen-fluorine bond. A superior performance can be obtained, it is stated, if enough oxygen is mixed with the fluorine to consume carbon so that the full benefit of the hydrogen-fluorine reaction can be realised. This suggests the use of fluorine-oxygen mixtures which can be readily prepared and are stable; or the ready-made combination of oxygen difluoride can provide similar energy resources.

It is pointed out by Gall that there is at present no good way to make oxygen difluoride economically. The aim is to produce oxygen difluoride at a cost equal to or less than that of oxygen-fluorine mixture.

Chlorine trifluoride as an oxidiser is only intermediate in performance between nitric acid and oxygen. Its usefulness lies in the convenient vapour pressure (boiling point plus 12°C) and the good density, combined with permanent storability in standard materials of construction.

In bromine pentafluoride, the drawback of high atomic weight is greater, but this oxidiser in combination with selected fuel, is stated to give a propellant combination of notably high density, and should be considered seriously whenever over-all performance includes the total missile dimensions as significant factors.

Nitrogen trifluoride has good handling characteristics but like oxygen difluoride, effective manufacturing procedures are not available.

Need for Cheap Production

It is suggested that it is inevitable that fluorine will become an important rocket chemical. What is required is cheap production, learning to handle and ship it safely and to exploit it effectively.

Regarding US fluorine requirements adequate for the missile programme, it is stated than only a small percentage of the currently used fluorine would be needed. If demand was for 150 tons a month, this should be compared with the total US production of acid grade fluorspar, which is about 20,000 tons per month, equivalent to about 10,000 tons per month of elemental fluorine. Other resources of fluorine in the US are phosphate rock and by-product topaz. If necessary fluorspar could be obtained from Mexico and Canada.

The ideal fuel should possess high energy content per unit weight, high energy content per unit volume, be easy to handle and of low cost. Today, a new class of 'exotic fuels' encompass all these requirements. Liquid hydrogen with its high heat of combustion stands out, but its extremely low density requires a large storage system for a power plant and consequently a large refrigeration or insulation system. Beryllium, another suitable material, has been discarded because of its toxicity and its short supply.

Earl A. Weimuenster, Olin Mathieson Chemical Corporation, discussing the 'Utilisation of high-energy fuel elements' stated that the most promising area for research appeared to be the boranes. Although of lower heat of combustion per pound than liquid hydrogen, the boranes possess much higher heats of combustion than the hydrocarbon fuels. Pentaborane, for instance, is about 60 per cent better than J P-4, a commonly used hydrogen fuel. US efforts started in 1942 with extensive studies of the chemistry of the boron hydrides. In 1947, the UK made a survey which encompassed studies of boron materials to be used as ramjet fuels. About the same time US efforts began on combustion studies and the use of boron hydrides in rocket motors, ramjets, and air-breathing engines. Intensive studies have been in hand since 1952 as a result of which the HEF fuels are now being synthesised. (See CHEMICAL AGE, 27 July, p. 139.)

In fact in 1952 Olin Mathieson accepted a contract with the US Navy Bureau of Aeronautics on the ZIP project to prepare high energy fuels.

In general HEF fuels are prepared by treating boron-containing ores in such a manner that they are converted to useful intermediate boron compounds. Subsequent reactions of these intermediates convert them to the final products. According to Weilmuenster, the entire operation is a completely integrated process, requiring only the starting boron chemicals and a small amount of other materials for chemical make-up to compensate for final losses. By-products of certain steps in the process are re-cycled for use as reactants in some earlier processing steps.

Olin Mathieson are continuing to investigate alternative routes for certain specific operations, with a view to lowering costs and obtaining higher yields of products and conversion of reactants. The company has, in fact, three competitive routes for the conversion of the boron-containing ores. Competitive and economically feasible alternative routes are also available for every step of the present process.

Boranes

The two boron-containing materials of most interest are pentaborane and decaborane. Preparation is usually via diborane, the simplest of all the boranes. Simple application of heat is sufficient to convert the diborane to pentaborane and decaborane.

It is suggested that the HEF fuels meet the requirements for future high-speed missile and aircraft applications and the US view is that the day may not be far off when these fuels will be available for civilian as well as military uses.

A spokesman of Rocketdyne, a division of North American Aviation Inc., John F. Tormey, speaking on 'Liquid rocket propellants—Is there an energy limit?' suggested that some probable future trends of rocket fuels would involve increases of hydrogen content, of stability of combustion products, of stability of fuel, while future rocket oxidisers would involve increases of fluorine content, of stability and of boiling point.

Production costs of higher energy fuels and oxidisers will be in general, states Tormey, three times to six times the cost of conventional compounds, firstly, because they are man-made and, secondly, since high cost is also associated with the additional care given by producer and consumer.

Despite present problems, the chemical and thermodynamic situation is reported to indicate that higher energy rocket compounds are not to be ruled out for the future on chemical grounds.

'Homogenous solid propellants and the chemical industry' was the subject con-

sidered by Lyman G. Bonner of the Hercules Powder Co. Since the war, stated Bonner, demands of missiles and long range rockets have required still larger charges and thicker sections and these very quickly exceed the capacity of available extrusion equipment. However, a casting method has been successfully developed in which ingredients are incorporated in a mould or container having the shape and dimensions of the desired final piece of propellant.

Wartime demand at the peak of production of homogenous solid propellants for guns and rockets resulted in a production rate in excess of 100,000,000 lb. per month, corresponding to an annual consumption of at least 250,000 tons of cellulose, 50,000 tons of glycerol, plus corresponding amounts of ether, alcohol and acetone, and some minor ingredients. Regarding the outlook for the future of homogenous solid propellants in the US, it is stated that so far they have held their own very well against the competition of other classes of solid propellants and of liquids as well, in both rocket and missile applications.

The significant new materials are still cellulose, glycerol and nitric acid, plus certain plasticisers and modifiers selected from currently available material. The unmodified double-base propellants are capable of operation up to the same 240 to 250 lb.—seconds per lb. impulse limit of other systems. By the use of additives, too, they are capable of modifications to higher values.

Valuable Lessons

Nike Ajax, the first US operational supersonic guided missile which employs both liquid and solid propellant rocket engines, has provided valuable lessons for those concerned with chemical development, states R. B. Canright (Douglas Aircraft Co.). The booster used in Nike is a solid propellant rocket. The case enclosing the double-base propellant is made of heat-treated steel. Ignition is by an igniter composed principally of black powder and trench mortar sheet which is ignited by passing electric current through the squibs or electric matches contained within the charge.

Booster propellant is a modified double-base type, composed principally of nitrocellulose and nitroglycerine. This has been developed by Allegheny Ballistics Laboratory of Hercules Powder Co., under Redstone Arsenal sponsorship, and is now produced by a US government arsenal. Storage and handling are a major problem, as the propellant must be treated as a high explosive.

The original propellants in the sustainer propulsion system were white-fuming nitric acid as the oxidiser and JP-3 as the fuel, with the starting fluid a mixture of aniline and furfuryl alcohol. Use of a special propellant valve made possible the use of hydrocarbons in the propulsion system, but Canright states this would not have been required if a smooth-burning fuel, such as hydrazine, could have been used.

After much experimentation, addition of a relatively small amount of unsymmetrical dimethyl hydrazine (UDMH) was shown to increase fuel reactivity, eliminate combustion instability and, because of the water tolerance of UDMH, icing difficulties. The present fuel of UDMH and JP-4 is stated to be barely hypergolic and safer than straight JP-4. It has been designated M-3 fuel. About 1951, the oxidiser was changed from white fuming nitric acid (WFNA) to red fuming nitric acid (RFNA) containing added nitrogen dioxide to decrease corrosive attack on aluminium tankage. Further studies on acid composition showed that slight amounts of hydrogen fluoride added to nitric acid reduced the corrosion rate of aluminium and stainless steel as a result of a coating of metallic fluorides forming on the metal surface. Also, appreciable amounts of water and nitrogen dioxide incorporated with the acid stabilised it against decomposition under conditions of long-term storage at high temperatures.

Because of high pressure build-up of oxygen in the Nike tanks, the oxidiser was changed to IRFNA (inhibited red fuming nitric acid) containing a higher percentage of nitrogen dioxide than previously, as well as definite amounts of water and hydrogen fluoride. Now, even after months of storage at 140° F. relatively low pressures are built up and corrosion is stated to be negligible. A very slight amount of aluminium fluoride has been found at the bottom of the tanks, and as long as no water is used to flush the tanks, no deposits of aluminium nitrate are formed.

To prevent resinification of the starting fluid, triethylamine was added. However, ignition characteristics were unsatisfactory at extremely low temperatures. Investigation indicated that unsymmetrical dimethyl hydrazine had least ignition delay, so this was used instead. The final end product is a hypergolic propellant combination in a system which will operate over the temperature range of −50° to +140° F. (and, it is believed, well outside these limits) after long periods of storage. A probable loaded storage life of 5 to 10 years is suggested.

Squibb Explosion Evidence

No one would know the cause of the explosion, commented the coroner at an inquest held at Liverpool on 24 October, on a man who lost his life in an explosion at the factory of E. R. Squibb and Sons, manufacturing chemists, Woodend Avenue, Hunts Cross, Liverpool. Evidence was given that shortly before the explosion the man—Ronald McLean, aged 36—had been standing near a container of benzoyl peroxide. Near his body a box of matches was found in an overall pocket. The factory rules were that all matches must be surrendered on entering.

The production manager, Mr. Francis Michael Freeman, said the container of benzoyl peroxide had shattered. The lid had gone through the roof and landed on another roof 100 feet away. Mr. Thomas David Manley, research chemist, said benzoyl peroxide was not classified as an explosive, but in certain circumstances it would decompose violently. This would happen if a single granule became heated by a spark or blow, and the explosion might therefore have been caused by someone scraping the lid of the container in taking it off, or dropping it, or by hot ash from a cigarette. A further possibility was that McLean might have leaned heavily against the container and ignited some of the matches. There had never been an explosion with benzoyl peroxide since his firm in Luton had been manufacturing it.

A verdict of accidental death was recorded.

Expanding Applications of Cobalt

At the second general meeting of the Cobalt Development Institute last month, it was decided that research work on cobalt utilisation, undertaken this year, should be further developed in 1958. This work, commissioned with specialised organisations in Belgium and abroad, includes basic research and studies of a more immediate practical character aimed at extending the field of application of cobalt.

The Cobalt Development Institute was formed on 16 January this year. It is a technical and scientific organisation, with the world's major cobalt producers as its members.

The Institute aims to expand in all countries the existing uses of cobalt and search for new applications. Execution of its programme has been entrusted to the Centre d'Information du Cobalt, 35 rue des Colonies, Brussels, Belgium. The centre is represented in the US by the Cobalt Information Center, Battelle Memorial Institute, Columbus, Ohio.

Results and technical literature collected by the Centre in Belgium will be made widely available by all appropriate means including the editing of monographs and the publication of a periodical review, the first number of which is to be issued in the course of 1958. The Brussels Centre and the Columbus branch also provide information and advice on cobalt and its uses for customers.

ICI Incentive Schemes Success

The works study manager to the General Chemicals Division of ICI, Mr. C. C. Moss, told the Institute of Works Managers last week, that incentive schemes for maintenance workers in the division had resulted in work rising from the basis of 40 work units per hour to 70 or 75. It brought about a better team spirit, less absenteeism, and a remarkable improvement in the standard of cleanliness. Three basic requirements were necessary: A standard measure of work, a nucleus of trained estimators and a clerical system for recording purposes.

POLAROGRAPHY IN INDUSTRY

Symposium Speakers Discuss Recent Developments

THIRTEEN papers were presented at the two-day symposium 'Polarography in Industry' organised by the Polarographic Society and held at the Cora Hotel, London WC1, on 24 and 25 October. About 120 members and non-members took part. Opening the proceedings, Mr. G. F. Reynolds, chairman of the Society, gave a particular welcome to overseas visitors. He regretted that Professor Heyrovsky, president of the Society, was unable to attend.

Classical and instrument techniques all had their place said Mr. Reynolds. But he felt that polarography was the most versatile of analytical methods.

Coming events of the Society, he went on, included a one-day meeting in Birmingham next March on the subject of 'Education in polarography'. At this a film on the polarographic method, made in Prague, would be shown. In the autumn of 1959 it was proposed to hold an international symposium at Cambridge.

The following papers were presented: 'Recent advances in polarography' by Mr. G. W. C. Milner (AERE, Harwell); 'Plant control in the uranium industry' by Dr. H. T. Tucker (Hartebeestfontein Gold Mining Co. Ltd.); 'The wide-bore electrode and continuous oxygen recording' by Mr. G. Knowles (Water Pollution Research Laboratory); 'Determination of isopropyl nitrate' by Mr. A. F. Williams (ICI Nobel Division); 'The use of polarography in organic analysis' by Mr. G. E. Penketh (ICI Billingham Division); 'Review of polarography in Italy' by Professor G. Semerano (University of Padua); 'Design of microcells' by Dr. F. von Sturm (Siemens, Germany); 'Instrumentation for automatic control' by Mr. L. F. Nash (Evershed and Vignoles); 'Determination of trace elements in cast iron' by Mr. R. C. Rooney (British Cast Iron Research Association); 'Simultaneous determination of copper and iron' by Dr. K. J. Cathro and Dr. A. Walkley (CSIRO, Australia); 'Analysis of semi-conductor materials' by Dr. F. A. Pohl (AEG, Germany); 'Determination of iodide in photographic film' by Mr. G. Russell (Ilford Ltd.) and 'Twin electrodes in a.c. polarography' by Mr. R. L. Faircloth.

SYMPOSIUM LECTURE DESCRIBES RECENT HARWELL WORK

THE symposium Lecture, 'Some recent advances in polarography' was presented by Mr. G. W. C. Milner, Atomic Energy Research Establishment, Harwell, and was read in his absence by Dr. G. C. Barker, also of AERE, Harwell.

Conventional polarography, said Mr. Milner, was limited in its application to trace analysis, an aspect of importance in this atomic age. Scientists in the UK Atomic Energy Authority had designed new instruments to overcome difficulties associated with conventional instruments. They had produced the square wave polarograph, together with an improved form of the cathode ray polarograph, and the pulse polarograph which was still in the development stage and was on show at the symposium.

Improved Sensitivity

The square wave polarograph was at least 200 times as sensitive as conventional instruments. It was six times as sensitive as the cathode ray polarograph and 12 times as sensitive as the Cambridge Univector polarograph. Its main applications were the rapid determination of trace amounts of inorganic substances where it could be used in the molar range 10^{-4} to 10^{-7} or lower. It could be used in the presence of a 20,000-fold excess of a major constituent.

Applications had been found in the analysis of foodstuffs, metallurgical materials, effluents, fertilisers and minerals.

Maximum sensitivity of the instrument was limited by the instability of the capillary response which was associated with a tendency for solution to enter the capillary of the dropping mercury electrode. It had been shown that this effect could be reduced by the use of specially shaped capillaries. An improvement was also obtained by waterproofing a conventional capillary tip with silicone resin.

Another method made use of a polarising pulse with a duration of 1/25th of a second applied to the dropping mercury electrode once in the life of every drop. A pulse polarograph using this principle had been designed and was on show in the exhibition.

AERE had also developed a method using an amplitude modulated radio frequency current in place of the square wave voltage normally used in square wave polarography. Preliminary results suggested that this technique might eventually replace square wave polarography in many low level determinations.

Dr. H. T. Tucker, left (Hartebeestfontein Gold Mining Co., Transvaal), talking to Mr. W. J. Parker (secretary of the Polarographic Society) and Mr. G. Russell (symposium secretary)

Continuous Control of Ion Exchange

SINCE production of ammonium diuranate and the subsequent uranium oxide is now a major industry in the Union of South Africa the necessity had arisen for a rapid method of uranium analysis. By using polarographic techniques it was possible to carry out in a few minutes analyses which had previously taken five to six hours. This was stated by Dr. H. T. Tucker of the Hartebeestfontein Gold Mining Co. Ltd., who discussed 'Plant control in the South African uranium industry'.

In most cases the ore was first treated for the extraction of gold. At Hartebeestfontein, however, the uranium was leached out first by air agitation in the presence of sulphuric acid and manganese dioxide. Prior to filtration, flocculants, commonly animal glue, were added. Uranium and iron were then adsorbed on to an anionic exchange resin, IRA 400. The uranium and iron were eluted with nitric acid-ammonium nitrate mixture and the uranium precipitated after removal of the iron.

Control analyses were required on the incoming pulp feed (head sample) and the filtered residue pulp. Chief difficulty was the large amount of ferric iron present.

l. to r., Dr. I. S. Longmuir (editor, Journal of the Polarographic Society), Mr. R. J. Motz (Mars Ltd.) and Mr. A. Warren (Ministry of Supply)

It was found that best results were obtained using either a tri-electrode or well electrode. The tri-electrode consisted of three dropping capillary electrodes in close proximity, connected to a single mercury reservoir. The well electrode consisted of a 2 mm. glass tube, the end of which was bent in a U shape and immersed in the sample solution.

The best supporting electrode was found to be a mixture of L-ascorbic acid and tartaric acid with carboxymethylcellulose as maximum suppressor.

Procedures were described by Dr. Tucker for the determination of uranium in ore samples using an alkaline-supporting electrolyte, using an acidic-supporting electrolyte, and in an acid solution.

In the second part of his paper Dr. Tucker considered the control of ion exchange recording units by a continuous recording polarographic technique. Previously, determinations had been carried out by unskilled workers and the results had varied considerably. The polarographic technique, using the ascorbic-tartaric acid electrolyte in conjunction with a cell capable of handling a continuously flowing sample, produced accurate results he stated. Consumption of mercury had been reduced to a minimum by dispensing with the mercury pool and using a mercury-coated silver wire anode.

Continuous Oxygen Determination in Rivers and Effluents

THE usual type of dropping mercury electrode was found to be unsuitable for recording dissolved oxygen in streams, sewage effluents and similar liquids. It was found that it would not remain on calibration for more than a few hours in running tap water and conditions in the field would be expected to make the position worse.

An alternative apparatus was described by G. Knowles, R. Briggs and G. V. Dyke, of the Water Pollution Research Laboratory, Stevenage, in their paper on 'The wide-bore dropping mercury electrode and its application for automatic recording of dissolved oxygen'.

The wide-bore electrode, first described earlier this year, has been found to hold its calibration indefinitely. Its construction is shown in the diagram.

Standard Adopted

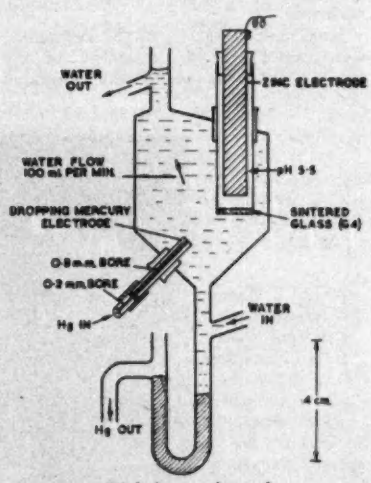
Capillaries from 0.4 to 1.05 mm. internal diameter were tried and found satisfactory, but 0.8 mm. was adopted as standard. A Pyrex capillary has been used for recording dissolved oxygen, but a 0.8 mm. capillary drilled in Perspex has been found satisfactory for square wave polarography. Perspex can be used in solutions containing hydrofluoric acid.

No special precautions have been found necessary for keeping the tip clean in wide-bore electrodes. For continuous recording it was found convenient to pass the water under test through a cell containing the electrodes at about 100 ml. a minute.

Drop times used with the conventional dropping mercury electrode are suitable for the wide-bore type. Currents given by the wide-bore type are five to ten times those given by the usual one, and the reference electrode must be capable of carrying these larger currents without polarisation. The electrode shown in the figure consists of a pure zinc rod in a buffer of pH 5.5.

Mercury consumption is 6 ml. an hour. Special arrangements have been devised for maintaining a constant head of mercury and providing a suitable drop time.

It was decided that the best fixed voltage to apply for recording dissolved oxygen would be —0.5 volts with respect to the zinc electrode (—1.5 volts vs. the saturated calomel electrode). At this voltage cyanide and sulphide will not interfere. The diffusion was found to be unaffected by the conductivity of the water, provided it was at least 50 microhms per cm. cube, or by the pH in the range so far tested (5 to 8.5).



Wide-bore electrode

The indicating meter must be graduated to read directly in parts per million of oxygen and therefore some method of compensating automatically for increases in polarographic current with temperature was necessary. Methods were described for obtaining suitable calibration curves.

When mains power was available the concentration of dissolved oxygen was continuously recorded on a strip chart. When only battery power was available the meter was photographed automatically at regular intervals.

Two field experiments over many weeks, one on sewage effluent and the other on a small polluted river, gave a mean error of 0.00 p.p.m. by weight. Standard deviation about this mean was 0.06 p.p.m. Concentration of dissolved oxygen ranged from 2.2 to 11.0 p.p.m. and temperatures from 5 to 20°C.

Discussion on Tucker and Knowles' Papers

Mr. J. G. Baber, Glaxo Laboratories, Ulverston, asked Dr. Tucker to amplify on the dropping mercury electrode.

With the aid of a diagram Dr. Tucker showed how electrodes could be constructed by fixing, with a rubber band, a piece of Cellophane over the end of a glass tube and piercing the Cellophane with a fine needle. The method, said Dr. Tucker, was useful 'when you are stuck for capillaries'.

Mr. Baber then asked Mr. Knowles if the application of wide-bore electrodes had been contemplated for fermented broths. Mr. Knowles said that he believed one or two companies were interested.

Dr. W. Stross, International Alloys, wanted to know why Dr. Tucker used a mercury-coated silver electrode. Dr. Tucker replied that nothing else had been tried. Dr. Stross also asked why ascorbic acid was used and not the more common hydroxylamine. Dr. Tucker said that hydroxylamine hydrochloride had been used for about three years. With large concentrations of iron it took some time for complete reduction to take place. Heat was found to be necessary. Ascorbic acid was more suitable.

Both speakers were asked by *Mr. J. V. Westwood*, British Insulated Callenders Cables, if systems using solid electrodes might be applied to their problems. Replying first, Dr. Tucker said that they had not been used to the best of his knowledge in his type of work. Mr. Knowles said that they were not stable under most conditions and calibration had to be carried out frequently, perhaps several times a day.

Asked by *Mr. R. C. Rooney*, British Cast Iron Research Association, how he calibrated his electrodes, Mr. Knowles said that he used the Winkler method.

l. to r., Mr. B. B. Bach (Mond Nickel Co.), Mr. T. R. B. Davies (Electronic Instruments), Mr. K. Baker (Medical Research Council), Mrs. J. M. Griffiths (Chemical Research Laboratories, Teddington),

Mr. R. C. Rooney (British Cast Iron Research Association), Mr. F. Seddon (Petrochemicals), Mr. I. H. Ruddle (ICI Welwyn Garden City) and Mr. D. O. Singleton (Beecham- Maclean)

Applications of Polarography to Organic Analysis

IT WAS ONLY in recent years that organic analysts had made substantial use of polarography said Mr. G. E. Penketh, Imperial Chemical Industries, Billingham division, in a paper entitled, 'The use of polarography in organic analysis' Although the first organic reduction (nitrobenzene by Shikata) was carried out in 1925, the number of papers in the succeeding 20 years was small and results suffered from lack of reproducibility. Irreversible waves were the rule and conditions were much more critical than for inorganic reactions.

Lack of attention to the pH was perhaps the greatest cause of error in early work, said Mr. Penketh. A typical organic electrode reaction was:

$$X = Y + 2H^+ + 2e \rightarrow XH - YH$$

and the half wave potential and diffusion current were affected by pH. Alteration of the pH could also cause variation of the form of the electroactive species.

The amount of organic solvent added had to be rigorously controlled. Totally non-aqueous media could be used provided the electrolytic resistance of the medium was small.

Qualitative analysis in the sense of analysing virtually unknown solutions became almost impossible with the polarograph, said Mr. Penketh. The main analytical applications were quantitative and in this case rigid standardisation of conditions was essential.

One of three methods of calibration could be used:

(1) The standard series method in which the current obtained from the test solution was compared with the values obtained from a series of standards.

(2) The internal standard method in which the diffusion current of the sample was measured. A small measured amount of the compound was added and the current measured again. The amount of constituent was obtained by proportionation.

(3) The pilot ion method. Here the current due to the constituent was compared to that of some component added in known amount. The method, which suffered from the difficulty of finding a suitable component whose behaviour resembled the constituent to be determined, was useful for the determination of unstable substances.

Removal of oxygen was another difficulty in organic polarography because of the volatile nature of many sample constituents or solvents.

Mr. Penketh then went on to describe eight applications of polarography in organic chemistry:

(1) *Determination of organic contaminants*, e.g. 1:4 naphthoquinone in phthalic anhydride.

(2) *Inorganic contaminants.* These could often be determined without the destruction of organic matter.

(3) *Multicomponent mixtures.* An example was mixtures of aldehydes which could be divided into three groups, unsaturated aldehydes, formaldehyde and saturated aldehydes.

(4) *Isomers.* It was possible to determine the proportions of the N-nitroso and 4-nitroso compound obtained by the treatment of diphenylamine with nitrous acid.

(5) *Following the course of reactions* where either one of the reactants or the product were reducible.

(6) *Analysis of non-reducible materials.* These could frequently be determined by conversion to reducible materials.

(7) *Chromatography.* Polarography could be used to follow the course of chromatographic separations.

(8) *Oxidations.* In this case electrodes other than mercury generally had to be used.

Estimation of Isopropyl Nitrate

'ISOPROPYL nitrate was used as a starter fuel and during its manufacture it was necessary to have an analytical procedure which can be employed for its determination in small amounts, particularly in the atmosphere,' said Mr. A. F. Williams, Imperial Chemical Industries, Nobel Division, introducing his paper, 'The polarographic determination of isopropyl nitrate'. Co-author of this paper was Mr. J. Brooks, also of ICI Nobel Division.

Surveying earlier work, Mr. Williams said that very little had been published on the chemical determination of small amounts of the aliphatic esters of nitric acid, presumably because of hydrolysis difficulties. Polarographic studies had also been made but no reliable data was available.

Describing the method they had developed at ICI, Mr. Williams said that experiments had shown that results were affected by the amount of water present and by the time and rate of deoxygenation. This last effect could not be explained. If the experimental techniques were standardised then the polarographic method could be used.

Methanol solutions (10 ml.) containing 5 per cent water and 0.00025 g. of nigrosine as maximum suppressor, and O.1M with respect to lithium chloride, were prepared with known amounts of isopropyl nitrate. Wave heights were measured at the half-wave potential of -1.45 volts vs. the mercury pool. Heights were found to be proportional to concentration. The method had been applied to the determination of small amounts of isopropyl nitrate in the atmosphere, using methanol immersed in Drikold as absorbent.

Initial work has been carried out on a conventional Tinsley polarograph. The more sensitive cathode ray polarograph had been tried with success.

Penketh and Williams' Papers Discussed

Mr. G. Russell, Ilford Ltd., mentioned the lack of reproducible work on glyoxal. He said that earlier workers, using NH_4Cl, had obtained results at −1.5 volts which was in fact the value for HCl.

Mr. R. J. Thompson, Distillers Co., said that oxygen was removed more rapidly if small bubbles were used. If the bubble time in the pre-saturator was not sufficient, then losses occurred.

Mr. Penketh agreed. Removal of oxygen was difficult. Organic solvents took up more oxygen than did water.

Talking with Dr. F. von Sturm (Siemens-Schuckertwerke, Germany) on the right, is Mr. D. R. Curry (Services Electronics Research Laboratory)

Mr. M. J. Jackman, North Thames Gas Board, asked for more details on phenol determination. Mr. Penketh said that Gaylor and co-workers had determined phenol using graphite electrodes.

Asking for more information on carcinogens, *Mr. W. J. Parker*, Mervyn Instruments, spoke of the resistance of the medical profession to polarographic methods. 3:4-Benzpyrene was reducible at −1.8 volts. He wanted to know if there was any further information, together with information on cyanide.

Mr. Penketh could only say that some work on 3:4-Benzpyrene had been done by ICI.

It was suggested by *Mr. H. I. Shalgosky*, AERE, Woolwich, that deoxygenation was not always necessary. Mr. Williams agreed but said that one of the objects of his paper was to find out why he lost isopropyl nitrate in the process.

Mr. Jackman asked for suggestions for analysing mixtures of phenols. Mr. Penketh suggested conversion to quinones which gave waves removed from other organic compounds.

A speaker asked for methods for organic sulphides. Mr. Penketh could not suggest any. Sulphur and disulphides were reducible and mercaptans could be converted to the disulphide by free sulphur.

Another speaker asked whether sulphones could be reduced. Mr. Penketh said that he did not recommend polarography for acids or amines as catalytic waves were obtained.

Mr. R. Goodey, Distillers Co. (Biochemicals), wanted to know whether complexones had been used in organic polarography. Although he did not know whether much work had been done on the subject, Mr. Penketh said it was a worthwhile field of study. He thought the method would work.

Analysing Very Small Volumes

VOLUMES of solution as small as 0.05 ml. which could be handled in cells were described by Dr. F. von Sturm, Siemens-Schuckertwerke AG, in his paper entitled 'Polarographic determinations in micro-cells'.

The exacting requirements of chemical analysis for the detection and analysis of small amounts of substances made it necessary to extend polarography to the analysis of still lower concentrations and smaller volumes. The use of small volumes had the advantage over dilute solutions that fewer reagents were required.

Dr. von Sturm's cell had the following properties:

(1) Minimum volume of solution 0.05 ml.

(2) Allows measurement of limiting currents.

(3) Separated unpolarisable reference electrodes making possible (a) determination of half-wave potentials, even when following the three electrode technique and (b) controlled-potential coulometry.

(4) De-aeration of the electrolyte in the cell, and electrolysis with exclusion of air.

(5) Convenient handling and easy cleaning because of the exchangeable ceramic diaphragm.

The cathode compartment consisted of a glass cell of 3 mm. internal diameter. A thermosttated jacket could be fitted round the cell or it could be connected to a calomel electrode, making determination of half-wave potentials possible. Nitrogen was used for de-aeration. Before entering the cell the nitrogen was saturated with the vapour of the solvent being used to avoid losses by evaporation.

Dr. von Sturm described in detail the uses and capabilities of the micro-sell. It was possible for example, he said, to detect 0.015 μg of zinc or 0.025 μg of tellurium. It was also possible to carry out reliable half-wave measurements even if only microgramme or smaller amounts were available.

By using the chloride titration with $Hg_2(NO_3)_2$ the accuracy of the cell for amperometric titration was checked. Results varied from —1 to 4 per cent deviation from theoretical. The main error was attributed to imperfect volume measurement.

Millicoulometric determinations could be carried out in cell. After describing the theory of the method, Dr. von Sturm went on to give an account of its application to the determination of europium and to the determination of the number of electrons involved in the electrode reaction of the chromate and cadmium ions.

Finally Dr. von Sturm mentioned the use of the capillary cell which could be used for tests on very small volumes of solution, of the order of 5 μl.

Dr. Von Sturm's Paper Discussed

Dr. I. S. Longmuir, Institute of Diseases of the Chest, wanted to know if there were any biological applications of his methods. Dr. von Sturm said that they were not being studied but he had them in mind.

Asked how he concentrated his solutions, Dr. von Sturm said he used ion exchange.

Polarography in Italy

PROFESSOR G. Semerano, Polarographic Centre, University of Padua, Italy, gave a comprehensive review of the Centre, of which he has been the director since 1947.

Work had been done on the development of polarographic methods both for organisations in Italy and elsewhere. The Centre was financed by the Italian Government.

Currently the Centre was concerned with the purity of polarographic reagents. They were endeavouring to obtain better reagents. In Professor Semerano's opinion the quality of Italian polarographic reagents was better than the earlier British reagents.

Assay of Trace Elements

METHODS of sensitive polarographic analysis had been worked out in AEG laboratories for a large number of elements said Dr. F. A. Pohl, AEG Forschungs-Institut, Belecke on Mohne, Germany, presenting his paper, 'Polarographic determination of impurities in semi-conductor materials.'

Basic principles of their working method could be summarised as follows:

(1) Use of specially purified reagents and solvents.

(2) Avoidance of inorganic salts as reagents.

(3) Avoidance of vessels and devices which might yield impurities.

(4) Limited change of vessels during analysis.

(5) Avoidance of precipitation of the main constituent.

(6) Exclusion of the laboratory atmosphere as far as possible.

As an example of this method Dr. Pohl described the determination of copper, cadmium and other elements in diode gold wire. As gold would form an amalgam with the mercury it had to be removed.

The gold (10 to 50 mg.) was dissolved by aqua regia in a small quartz tube; the acid was evaporated, the residue dissolved in 3N hydrobromic acid, and the gold repeatedly extracted with diisopropyl ether.

The residue in the tube was dried, organic matter was destroyed by fuming with perchloric acid, and the residue dissolved in the base electrolyte, 6N ammonia. The solution was transferred to a polarographic microcell. Oxygen was removed by passing a stream of hydrogen which had previously been passed through 6N ammonia. The solution was then polarographed for copper and cadmium.

A similar procedure for the determination of thallium, iron, copper, cadmium, bismuth and lead in selenium was also described.

Dr. Pohl concluded by stressing the need for extreme cleanness of the laboratory. Purification and storing of the vessels had to be carried out with the same care as the analysis itself. The same applied to the cleaning of work tables and ventilation hoods. These tasks could not be left to non-professional assistants.

Mr. R. C. Rooney, BCIRA, was interested in the use of polythene for storing solutions. Did impurities leach out into solution?

Dr. Pohl said that polythene was cleaned with concentrated hydrochloric acid followed by washing with double distilled hot and cold water. No increase of reagent blanks was found. They hoped eventually to use Teflon containers.

Dr. Pohl was asked about purification of hydrofluoric acid. He replied that this was always difficult. They used a platinum-silver apparatus. The commercial acid always contained about 10^{-4} per cent of lead. Three distillations reduced this to 10^{-6} per cent. It was impossible to go below 10^{-7} per cent.

Mr. D. R. Curry, Services Electronic Research Laboratory, said that hydrofluoric acid could be distilled in polythene. Dr. Pohl replied that he had distilled methanol over caustic soda in a polythene apparatus.

Twin Electrodes Overcome Impurity Interference

TWO WORKERS from AERE, Harwell, Dr. G. C. Barker and Mr. R. L. Faircloth, described the use of 'Twin electrodes in a.c. polarography'. Mr. Faircloth read the paper.

He said that alternating voltages in the same phase could be supplied to the two cells and the currents subtracted, or voltages differing in phase by 180° may be used and the currents added. The technique could be called subtractive, rather than derivative, a.c. polarography and it could be used to reduce or eliminate undesired responses produced by impurities in the supporting electrolyte, by traces of oxygen in the gas used for deoxygenation of the solutions, by current associated with the low a.c. impedance of the double-layer capacity of the dropping mercury electrode and by imperfections in the electrode.

The technique could occasionally be used to obtain improved precision.

The two cells formed two of the arms of a type of impedance bridge and an unknown concentration of an ion in one cell was compared with a known concentration in the second cell. The technique could also be used for separating overlapping polarographic waves.

When applied to different types of a.c. polarograph the twin electrode technique gave better results: by elimination of background current in the case of the Breyer and Hacobian instrument (the simplest instrument); by reducing responses due to impurities in the case of the Cambridge Univector; and by eliminating the capillary response and responses obtained by base solution impurities in the Mervyn-Harwell square wave polarograph.

By means of a circuit Mr. Faircloth showed the application of the technique to the Mervyn-Harwell square wave polarograph.

Speaking of the possibilities of the technique it was stated that the square wave polarograph could not resolve waves whose half-wave potentials differed by less than about 50 millivolts. It was also impossible to measure wave height when the wave was superimposed on a wave produced by reduction of a major component of a mixture. In both cases the twin electrode technique was of use.

An example was given of the determination of lead ion in the presence of a large excess of thallous ion. For thallous ion concentrations below 4×10^{-4}M the results suggested that lead ion could be determined with an accuracy of 10 per cent or better in the presence of a 25-fold excess of thallous ion.

The method was also applicable to the separation of cadmium and indium waves and to the determination of lead in the presence of tin.

Mr. Faircloth concluded with a reference to RF (radio-frequency) polarography, in which he said that many background responses could be eliminated by the twin electrode technique.

Discussion

Describing the work as a tremendous advance in polarography, *Mr. W. J. Parker*, Mervyn Instruments, suggested the use of flowing solutions. Mr. Faircloth did not think it would work.

Mr. A. Warren, Ministry of Supply, raised the point of jet instability and intrinsic accuracy. No one, he said, had bothered with jet construction. The ordinary jet with square ends had a discontinuity which no engineer dealing with fluid flow would accept. The same applied to semi-circular ended jets. A few shillings spent studying conditions at the end of the jet would be well worth while. Any good optical firm could make jets to a given specification.

Mr. G. F. Reynolds, chairman of the Polarographic Society, introducing the symposium

Dr. Barker disagreed with Mr. Warren. He said that the jet was an essentially unstable system. He gave reasons for the bulb type capillary which they had developed.

Asked by a speaker for details on how to make the bulb capillary, Dr. Barker said he did not think it was suitable for general use. The end of the tube was placed in a hot flame and rotated while compressed air (10 lb. per square in.) was blown through it.

The View of The Engineer

PRESENTING 'An engineer's view of polarography' Mr. L. F. Nash, Evershed and Vignoles Ltd., said that there were two different types of engineer interested in polarography. First there was the instrument engineer whose job it was to produce a saleable commercial instrument. The flow of information was from scientist to engineer. Second was the instrumentation or process control engineer who was concerned with saving labour and fuel or increasing the throughput of a process. The flow of information was from engineer to scientist.

Polarographs had been becoming very complex in recent years but to neglect the simple type of polarograph which could be universally applied, with certain limitations, was to do polarography a disservice, said Mr. Nash.

Using a diagram of the basic polarographic circuit he showed how it developed with the addition of amplifiers with large negative feedback, together with damping to eliminate drop noise and to produce a polarogram representing peak values only.

Process Control

To illustrate the possible application of polarography to process control, Mr. Nash took as his example an oil refinery process in which additives had to be blended with the main spirit in critical amounts. The distance from sampling point to laboratory could be as much as a mile and even with a continuous sampling line a delay of at least four minutes was probable.

Suggesting the use of polarography in such cases, Mr. Nash said that a multiple polarograph could be used or a very fast single instrument on a time sharing basis. There was something to be said, however, for using a separate single polarograph for each loop. This would have the advantage of requiring a lower standard of maintenance and providing output information that could be fed directly into existing control systems.

The real key to using the polarograph in this type of application was the development of less troublesome electrode arrangements and this, Mr. Nash concluded, was 'putting the ball back in your court'.

Discussion

Dr. H. T. Tucker, Hartebeestfontein Gold Mine, Transvaal, said that he was directly concerned with polarography on a plant. He had tried to overcome mercury difficulties by using solid electrodes. Mr. Nash agreed that this could be done.

Mr. G. E. Penketh, ICI Billingham, said that some sort of base electrolyte was necessary. Removal of oxygen was difficult. According to Mr. Nash this was the polarographer's problem and not the engineer's.

It was pointed out by another speaker that the stream for analysis did not have to be returned to the flow line.

Cast Iron's Complex Nature Presents Analytical Difficulties

DIFFICULTIES encountered in cast iron analysis were described in a paper entitled 'The polarographic determination of trace elements in cast iron' by Mr. R. C. Rooney of the British Cast Iron Research Association.

Up to the present the polarograph had not been widely used in cast iron analysis, said Mr. Rooney. Reasons for this included the early reduction of iron to the ferrous state and the extremely complex nature of the material. The direct determination of copper and lead was the only polarographic procedure described in the United Steel Companies' handbook of methods.

Copper, cobalt and nickel could be determined together, said Mr. Rooney, and a number of combined procedures had been published. Manganese could also be determined polarographically but direct spectrophotometric or volumetric methods were more convenient. Methods for chromium usually entailed precipitation of the iron as hydroxide, followed by polarography of the chromium as chromate in alkaline solution, but direct conventional procedures were again more convenient.

A similar method had been described for vanadium, but methods employing precipitation of the iron suffered from the disadvantage of co-precipitation.

Many workers used classical methods of separation of the element to be determined before applying polarographic procedures.

The square wave polarograph had been used to determine minor and micro constituents in steel.

Separation Procedure

In Mr. Rooney's opinion the difficulties caused by the large number of elements present in cast iron would not be overcome by instrumental improvement and it was obvious, he said, that some form of separatory procedure must be used.

Sensitivity was the basic reason why BCIRA had chosen polarography for cast iron trace element analysis. The modern polarograph would determine metals at a much lower concentration than the limiting concentration for many of the available colorimetric reagents. Polarographic methods were also more convenient because more than one element could be determined in a given solution.

Methods in various stages of development at BCIRA were reviewed by Mr. Rooney.

BCIRA's first real 'trace' method was for lead and bismuth and was capable of detecting 0.000001 per cent of these metals. Iron is removed by butyl acetate extraction of the chloride followed by reduction of the residual iron. Other elements are complexed by tartrate and cyanide at pH 11. Lead and bismuth are extracted as their diethyldithiocarbamate complexes in chloroform. Organic matter is destroyed and the elements determined in a tartrate base electrolyte at pH 4.5.

The method developed for aluminium was capable of determining contents down to 0.1 p.p.m. After mercury cathode electrolysis, residual iron, together with titanium, vanadium, zirconium, niobium, etc., are extracted as cupferrates at pH 0.3. The pH is then adjusted to 4.5 and the aluminium cupferrate extracted. Organic matter is destroyed and the aluminium determined by the Willard and Dean method using Solochrome Violet RS.

In the procedure being developed for zinc, the metal is absorbed on a column of Deacidite FF from 2N hydrochloric acid and then eluted with dilute nitric acid. The polarographic determination uses an ammonia base electrolyte.

Cobalt is separated by extracting ferric chloride with butyl acetate and then extracting the cobalt as its α-nitroso-β-naphthol complex into chloroform. After destruction of organic matter the cobalt is determined in ammonia base electrolyte.

Tin and antimony are co-precipitated on manganese dioxide, followed by a polarographic determination.

Separation of copper is by extraction of the diethyldithiocarbamate complex into chloroform from a solution containing EDTA and other suitable complexing agents. The determination is carried out in ammonia base electrolyte.

A solvent extraction separation is envisaged for cadmium, probably as diethyldithiocarbamate from a suitable complexing solution.

Referring to Mr. Rooney's difficulties with trace elements in reagents, *Mr. D. R. Curry*, Services Electronics Research Laboratory, said that the Polarographic Society was trying to do something about this problem.

Commenting later on this remark by Mr. Curry, the Polarographic Society said that they were trying to secure the co-operation of other organisations faced with the same problem. A committee was being formed with the intention of preparing a report specifying the maximum limits of certain impurities which were troublesome to polarographers and other analytical chemists.

The report will be submitted to the pure chemicals manufacturers and it is hoped that the level of blanks in polarographic determinations will be considerably reduced. At present the reagent blank often exceeded the unknown to be determined.

Polarography in Photographic Industry

PHOTOGRAPHIC negative materials often consisted of silver bromide containing a proportion of silver iodide, said Mr. G. Russell, Ilford Ltd., in his paper on 'Polarographic analysis of photographic films: determination of silver iodide'. The function of the iodide in such cases was still a matter for research. A good method for determination of iodide was necessary.

Three volumetric methods were described by Mr. Russell, each of which was found unsatisfactory in practice. It was concluded that a simple method of adequate sensitivity could be developed, based on oxidation to iodate and direct polarography of the latter in alkaline solution.

It was found that the gelatin in the film had to be separated by fixation of the halides. The most convenient fixing agent proved to be saturated potassium bromide (ca 5M.). It was necessary to pre-harden the emulsion layer with formaldehyde because potassium bromide tended to soften gelatin. Oxidation was effected by liquid bromine.

Full details for preparation of a suitable solution were given by Mr. Russell. It was found that the half-wave potential of the iodate was —1.06 volts vs. the mercury pool. The potential of the latter was defined mainly by the 2M. potassium bromide in the solution. By measurement it was found to be —0.16 volts vs. the saturated calomel electrode (SCE). This gave a value for the iodate of —1.22 volts vs. the SCE.

The iodide concentration was derived from a calibration curve prepared by treating known amounts of silver iodide and silver bromide in the same way.

To compute the molar percentage of silver iodide it was necessary also to know the total silver content of the sample. This could be measured polarographically using a 1 ml. aliquot of the bromide solution used to fix the film.

Methods of calculating the result were shown. For 14 iodide measurements the standard error was found to be —1.5 per cent which was considered satisfactory.

By suitable modifications the method could be used on very small samples of film, down to as little as 5 sq. cm.

Copper and Iron Combined Assay

A CONTRIBUTION from the Commonwealth Scientific and Industrial Research Organisation, 'The simultaneous determination of copper and iron' by Mr. K. J. Cathro and Mr. A. Walkley, was read by Mr. R. L. Leake, Chemical Inspectorate, Ministry of Supply.

There was very little in the literature on this subject, which was important in copper winning both for investigational purposes and for plant control. However, work had been done using EDTA, Complexone IV and Tirone.

Experiments were carried out in a Leeds and Northrup type E instrument using a conventional H-type cell with an agar plug separating cathode and anode.

A linear relationship between diffusion current and concentration of both iron and copper was found over a 100-fold concentration range to within 2.5 per cent for EDTA and Complexone IV. Results for Tirone were unsatisfactory.

When copper and iron concentrations were comparable, EDTA could be used; but at copper to iron ratios in the region of 100 to 1 Complexone IV was better. Root mean square differences compared with standard analytical methods were ±1.7 per cent for iron and ±1.5 per cent for copper. Overall time for the double determination was about 20 minutes.

A view of the exhibition of polarographic apparatus. l. to r., the Water Pollution Research Laboratory's wide bore dropping mercury apparatus for continuous oxygen determination, the Cambridge Instrument Co.'s Univector, Southern Instruments' cathode ray polarograph, two instruments by Evershed and Vignoles, and the Mervyn-Harwell square wave polarograph

Symposium Exhibition of Polarographic Apparatus

As part of the symposium an exhibition of polarographic instruments was held at which seven organisations participated.

The *UK Atomic Energy Authority*, Harwell, Berks, showed the pulse polarograph designed by Barker and Gardner and mentioned in Mr. Milner's paper. While operating on the same basic principle as the square wave polarograph, it is said to avoid several disadvantages inherent in the former. Main advantages of the square wave polarograph which are retained in the pulse polarograph are high sensitivity, which makes it possible to work in the range 10^{-6} to 10^{-8} M, and the ability to detect traces of one component in the presence of large amounts of another which is more easily reduced. A disadvantage is the necessity of using base electrolyte solutions which are not more dilute than 0.5 N and which must be specially purified. Again the sensitivity for partially reversible reductions is lower than that for completely reversible ones. These disadvantages can be overcome by using a square wave of lower frequency, or more conveniently, a rectangular pulse which also allows normal as well as derivative polarograms to be recorded.

To obtain a normal polarogram the dropping mercury electrode is held for most of the time at a fixed voltage relative to the anode of the cell, but at a certain time in the life of each drop a polarising pulse changes the voltage for $^1/_{25}$ second to a more negative value, the amplitude of the pulse increasing gradually while the polarogram is being recorded.

Electronic circuits compute and record the difference between the average cell current during the second half of the pulse and that which would have flowed if the potential had not changed. The same circuits are used to obtain a derivative polarogram, but in this case the drop potential changes continuously and the amplitude of the pulses is constant.

Fuller accounts of all the papers presented at the Symposium will be published later this year in the 'Journal of the Polarographic Society'.

Used as a derivative polarograph the pulse polarograph is four times more sensitive for reversible reductions than the square wave polarograph, the disparity in the sensitivity for partly reversible and reversible reductions is reduced by a factor of ten, and base electrolyte solutions as dilute as 0.05 N can be used.

The Univector unit, designed for use with the direct-writing polarograph, was shown by *Cambridge Instrument Co. Ltd.*, 13 Grosvenor Place, London SW1. It is claimed that this will overcome the faults, inherent in d.c. polarographs, in particular the direct-writing instrument. These faults are: (1) the accurate measurement of small steps preceded by large ones is almost impossible and (2) the measurement of very small concentrations is uncertain mainly due to condenser current.

Sensitivity is said to be increased by 10 or in some cases 20 times that of the d.c. polarograph alone.

A manual polarograph, Model B Mark II, was shown by *Electrochemical Laboratories*, 5 Highfield, Wardle Road, Sale, Manchester. In this instrument two dials provide step by step adjustment of voltage by exact increments of 100 millivolts or 10 millivolts. Current values are plotted by simply clicking one or two rotary switches. It is claimed that this makes manual plotting of the polarogram very rapid and accurate.

Professor E. Gagliardo (Polarographic Research Centre, University of Padua, Italy) talking to Mrs. W. J. Parker

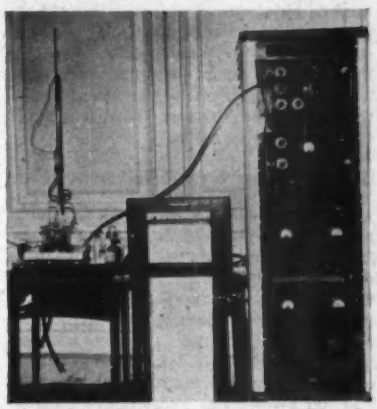
Two polarographs, the MK/19 recording instrument and the MK/16 Polarograph Minor, were shown by *Evershed and Vignoles Ltd.*, Acton Lane Works, London W4, together with electrolysis stands and ancillary equipment.

The MK/19 is similar to the MK/17 but is an all-mains instrument, the polarising potential being supplied from a stabilised rectified power unit; it also incorporates some slight modifications to the layout of the electrical components for ease of servicing. Its applications do not differ from those of the previous model.

The MK/16 is a manual operated instrument which has been designed specifically for the smaller laboratory and the teaching institute. It has a linear 9-in. scale and, although non-recording, incorporates a derivative circuit. In both instruments it is advantageous to use a special bent tip capillary in which the drops fall more rapidly than in normal polarography but are somewhat smaller, so that little or no damping need be applied.

Claimed to be the most sensitive polarograph available in the world, the Mark III Mervyn-Harwell square wave polarograph, made by *Mervyn Instrument*, Woking, Surrey, was on show. Designed in the form of a console, the electronic units are readily accessible. The operator sits in front of a Formica covered desk, facing the control panel.

A chart record showing a deflection of 1 mm. for concentration below 1 part in 10^9 can be obtained and trace elements can be detected and measured in the presence of major constituents in up to 20,000 excess.



The pulse polarograph demonstrated by the UK Atomic Energy Authority

Demonstrations of the use of the cathode ray polarograph made by *Southern Instruments Computor Division*, Frimley Road, Camberley, Surrey, to organic and inorganic determinations were given at the exhibition.

Also shown by Southern Instruments was the anodic conversion unit which enables the cathode ray polarograph to be used for the measurement of anodic waves without interference to the usual cathodic presentation.

The *Water Pollution Research Laboratory*, Elder Way, Stevenage, Herts, showed a working model of the wide bore electrode assembly described by Mr. G. Knowles in his paper, 'The wide bore electrode and continuous oxygen recording' presented at the symposium.

Applications of Nuclear Resonance Considered at OCCA Meeting

ONLY 11 years ago nuclear resonance was invoked, but this branch of spectroscopy has come to be applied to a quite extraordinary range of problems both in chemistry and physics. This was stated at the meeting of the London Section of OCCA on 22 October (Mr. H. C. Worsdall presiding), by Dr. R. Richards, M.A., D.Phil. (Fellow of Lincoln College, Oxford), who lectured on 'Nuclear Resonance'.

In an explanation of this new branch of spectroscopy, Dr. Richards said that, just as the electron had a spin, so did atomic nuclei. There was associated with that action a circulation of an electric charge; that circulation also gave rise to a magnetic moment, and the magnetic moment, as one would expect, was directed on the axis of the spin. Work was applied to it to twist it out of its preferred orientation, and its energy would rise so that it would eventually reach the anti-parallel position of orientation.

He discussed in some detail the way in which various chemical compounds could be dealt with by this relatively new laboratory tool.

In the discussion which followed Dr. Richards' lecture it was asked, if one had a polymeric compound with a few hydroxyls in it, how low a proportion of hydroxyl one could find by the nuclear resonance method? Dr. Richards replied that the method never would be one of tremendous sensitivity comparable with that of infra-red, except in very special cases. To study the deuterium nuclei in natural abundance in ordinary water one would have to build the most sophisticated apparatus that could possibly be built.

'Very Great Power'

In reply to a later question, Dr. Richards said that theoretically the method was of very great power as a quantitative tool. The intensities of the absorption lines would indicate how much of something was present and how many of the nuclei were responsible for any line. It did not indicate us anything else. So that in principle one could measure the intensity of a line and, knowing the intrinsic intensity of a proton, one could say that in a drop of material there were so many methyl groups. In practice the apparatus had not yet been defined sufficiently. But certainly one could do quantitative analyses for some cases, and it had been used in chemical industry.

The method of making measurements was extremely simple. There was a source of wireless waves. The sample to be dealt with was contained in a box, and one used what was really nothing more nor less than a wireless set working at television frequency.

Examples which Dr. Richards had chosen of the application of the nuclear magnetic resonance technique, said a speaker, were certainly of great academic interest, and one could appreciate the sort of applications it had to problems in which the association was interested. For example, one could see how it could give detailed information about the crystal structure of some of the organic pigments. It was delightful to see figures concerned largely with the detailed energetics of cobalt as a catalyst, which again interested the members of the association; and the speaker commented also on the use which might be made of the technique in the examination of drying oils. There they were interested in patterns of unsaturation —or, to put it in another way, in patterns of hydrogen atoms down a long chain— and one was impressed by the apparently easy way in which the spectra could be interpreted. From first principles one could draw a picture of what the spectra of a compound must be.

Regarding the question of cost it was stated that although, from the purely financial point of view, it might be some years before the technique came to be used widely in the industry, it was something which should be borne in mind.

Chemicals Exempted from KID

EXEMPTION for following articles from Key Industry Duty for the period beginning 28 October 1957 and ending 18 February 1958 is made an order of the treasury under section 10 (5) of the Finance Act 1926.

Molybdenum compounds, the following: Synthetic organic molybdenum compounds suitable for use as dyestuffs, colours, or colouring matters.

Synthetic organic chemicals, analytical reagents, other fine chemicals and chemicals manufactured by fermentation processes, the following: *mono*acetonylacetone; amyl alcohols containing not less than 58 per cent by weight of *n*-amyl alcohol and not more than 1 per cent by weight of aldehydes or ketones calculated as $C_8H_{10}O$; *N*-methyl-glucamine 3:5-diacetamido-2:4:6-tri-iodo-benzoate; phenoxymethylpenicillin.

This order is the Safeguarding of Industries (Exemption) (No. 9) Order, 1957, and is published (price 2d net, by post 4d) by HM Stationery Office, Kingsway London WC2, and branches.

Simon Group Report Plant Progress

PRINCIPAL new orders received by the chemical plant department of Simon-Carves Ltd., Stockport, are for a 100-ton plant using refinery hydrogen sulphide ordered through Simon-Carves (Australia) for the Shell refinery at Geelong and a 230-ton plant ordered through Simon-Carves (Africa) for the African subsidiary of Fisons Ltd. at Sasolburg. This is stated in the latest issue of the Simon magazine, *Group Review*.

The acid division is now commissioning two 50-ton-a-day sulphuric acid plants, one at Netherfield for R. and J. Garroway and the other at Hirapur for the Indian Iron and Steel Co. Erection on site is proceeding on the acid recovery plant for British Petroleum at their Kent refinery, the 140-ton acid plant for Fisons at Immingham and the 175-ton acid plant for Laporte Titanium at Stallingborough.

Plants under construction in India for ICI are: oleum plant; pot concentrator plant; nitric acid concentration plant; and an ammonium nitrite plant (all at Gommia) and a new polythene plant at Rishra. Other plants in hand are: 110-ton acid plant for Mary Kathleen Uranium in Australia, 110-ton plant for Kiwi Fertiliser Co. in New Zealand and two other 110-ton plants for the Bay of Plenty Fertiliser works and the Southland Co-operative Phosphate Co. (both New Zealand) and 184-ton acid plant for African Explosjves and Chemical Industries (Rhodesia).

Civil work began in the summer at Widnes on the tail gas mist precipators for the United Sulphuric Acid Corporation. Recent orders include three mist precipitators for British Titan Products Co. and an ammonia washer for the West Midlands Gas Board.

The acid section of Huntington, Heberlein and Co. Ltd. is about to send out an engineer to supervise erection of an acid concentration plant for the Pakistan Government and has almost completed erection of the wet contact sulphuric acid plant ordered through Woodall-Duckham for the North Thames Gas Board at Beckton. Instructions have been received for the modification and extension of the Norsk Spraengstof acid plant in Norway; the South Eastern Gas Board has ordered a ceramic filter for installation on the Simon-Carves Kachkaroff sulphuric acid plant at Phoenix Wharf.

Recent new orders received by Chemical Engineering Wiltons Ltd. include a 75-ton tar distillation plant for Salamon and Co. at Rainham, Essex, and a benzole rectification plant ordered by Simon-Carves as part of the coke oven by-product plant for Australian Iron and Steel at Port Kembla.

A Wilton engineer has recently gone to South Africa to supervise erection of the two 100-ton tar distillation plants for the Pretoria and Vanderbijl steel works of the Iron and Steel Corporation of South Africa. In Holland a 300-ton tar distillation plant has been started up at Geleen for the Dutch State Mines.

New I.C.I. Carbonylation Alcohols Plant

Capacity for the manufacture of carbonylation alcohols is to be extended by Imperial Chemical Industries Ltd. by installing a third unit at Billingham. This unit will produce an additional 20,000 tons per year of carbonylation products, the main outlet for which is in plasticiser manufacture. The first unit was started up in 1951, and the second about six months ago. It is expected that the new unit will be in operation by the middle of 1959.

The new unit will enable the company to increase further its exports of these important materials, as well as meeting an increasing home demand. Plasticisers are mainly used for compounding p.v.c.

Overseas News

US GENERAL ELECTRIC'S PRODUCTION OF SYNTHETIC INDUSTRIAL DIAMONDS

AN announcement made by the General Electric Co. of the US late last week indicates that the company expects to produce 3.5 million carats of synthetic industrial diamonds next year, equivalent to 50 per cent of the present US annual imports.

Using pilot plant, GEC have already produced 100,000 carats, which are being sold to industry for $4.25 a carat (£1.4 approximately). The present price for natural industrial diamonds is $2.85 (£1 approximately). The price of these synthetic diamonds is expected to become more competitive as production is increased.

No details concerning the process have been released for defence reasons. It is known, however, that the heat required to form the diamonds has been produced by electrical means and that GEC researchers have developed new means of distributing stress and giving support to the critical parts of the pressure cylinder used.

Distillation Plant Required by Iran Chemical Company

The Iran Chemical Co. Ltd. wish to purchase an acid distillation plant for their glycerine and soap factory. The plant required should be up-to-date and made from stainless steel (18/8 or V4A), resistant to fatty acids, and capable of handling 6,000 kg. of acid every 24 hours. Average acid value of the fatty acids is 185. The energy available is 40 kW 3 phase current, 50 cycles a second, at 220/380 volts.

Manufacturers are asked to write as soon as possible to Dr. Rassa, Director General, Iran Chemical Co. Ltd., Kuche Amiri, Avenue Hafez, Tehran. At the same time they are asked to notify the British Embassy, Economic and Commercial Department, Avenue Ferdowsi, Tehran, that they have done so.

Italian Chemical Industry Developments

Isveimer has authorised a grant of 300 million lire (£170,450) to Societa' Filza for the purposes of building a plastic-materials factory at Latina (south-west of Rome).

Output of petrochemical products in Italy during 1956, totalled 72,000 tons. It is reported that a larger figure will be recorded at the end of the current year, and a much larger one at the end of 1958.

The Information, Study, and Experiments Centre (CISE) in Milan is conducting an experiment, on semi-industrial scale, with a new method of producing metallic uranium. Two tons of sodium uranate have been obtained for this purpose from the French Commissariat for Atomic Energy.

A centre for nuclear studies, named after Enrico Fermi, is being created at the Polytechnicum in Milan. The new institution is to carry out research of an industrial character, produce radioisotopes, and train personnel in charge of reactors. It will be endowed with a water-boiler purchased from Atomics International, with a potential of 50 kW.

A commission consisting of a meteorologist, astrophysicist, and a specialist in nuclear problems, has been entrusted with the task of purchasing special equipment necessary for daily measuring of the radioactivity of air in Milan.

Hoechst's Building Cracking Plant

Farbwerke Hoechst is at present building at Hoechst plant for cracking light petroleum for the light olefins, ethylene and propylene. At the company's Gendorf works a cracking plant is using a process developed there, which, the company believes, will assure them a better entry into the field of ethylene oxide and its derivatives.

Ceramic Bonding Material

According to Consolidated Electrodynamics Corporation of California, US, a new ceramic-based bonding material, Ceramicite, forms a bond with stainless steel. This bond is said to be so effective that the molecules of the two materials, the Ceramicite and the stainless steel, become interlinked in the region close to the surface.

It is claimed, moreover, that this product will withstand temperatures approaching 900° F, and will remain unaffected when it is first heated to 800° F and then plunged immediately into ice-cold water. Also, electrical properties of seals made of Ceramicite are said to be 1,000 times better than those of comparable glass seals.

Cuprous Iodide—Human Anti-inflammatory Agent

A subsidiary of Vick Chemical, US, Jensen Salsbery, found during development work on cuprous iodide as a source of nutritional iodine for animals, that the chemical had a strong anti-inflammatory action in animals.

Chemical investigations are now being carried out by Vick Chemical. Indications to date are that it may give an action equal to that of corticosteroids at much lower costs.

Japanese Co-operation for Pakistan's Urea Plant

Full co-operation of the Japanese Ministry of International Trade and Industry has been assured for the Pakistan Industrial Development Corporation in regard to plans to construct and operate a urea plant in Dacca, East Pakistan.

A Pakistan delegation is visiting Japan to inspect Japanese chemical industries before the final contract for the construction of the plant is concluded.

The Japanese contractor, the Kobe Steel Works, expect the final contract to be concluded by the end of this month. Construction of the plant which is to have a capacity of 106,560 tons, is to start early next year and take about three-and-a-half years.

Germany's Chemical Industry Output Increases

In September, German industrial output was 3.4 per cent above the level of September 1956, the German Ministry of Economics announced last week. The largest rate of increase was achieved, however, by the chemical industry, with an increase of 11 per cent.

S. Rhodesia Castor Oil Plant

A pilot plant, costing about £40,000, for the extraction of castor oil from 40,000 to 50,000 tons of seed, is to be constructed at Gwelo next year.

Israel Chemical Expansion

Israel's first formaldehyde plant is to be erected shortly at Ashdod-Yam. It is estimated that the annual output of 3,000 tons will cover domestic requirements.

Poland's Expanding Chemical Industry

The Polish Government has recently appointed a special committee to prepare a 15-year plan for the expansion of the country's chemical industry—the aim being to achieve at least a six-fold expansion of output over the 1957 figures.

Output of plastics materials per head of the population of 16½ lb. is set as target, requiring a large-scale expansion of present productive facilities. This part of the programme is in fact considered as the most difficult of all the tasks facing the Polish chemical industry. Output of synthetic fibres is to reach a total of 130,000 tons a year or about 9 lb. per head of the population; 25 per cent of this output will consist of Terylene, Orlon and Steelon fibres.

Synthetic rubber with an annual output of about 70,000 tons is expected to cover fully domestic requirements. As regards basic chemicals, special attention is to be devoted to an increased output of soda in particular and the country hopes to be able to build up plant capable of an output equal to the most industrialised Western countries.

Japanese Fibre Manufacturers Negotiations with Du Pont

Patent rights to start production of Orlon in Japan are being sought by two Japanese industrial groups from E. I. Du Pont de Nemours Co. of the US.

Producers of acrylic nitrile monomer, the Nitto Chemical Co., have sent a

representative to Du Pont during October to discuss terms of a technical tie-up for Orlon production. It is reported that Nitto Chemical Co. represent the Kureha Cotton Spinning Co., and the Japan Gas Chemical Co., which are said to be jointly sponsoring a new company for Orlon production.

Said to be also sounding Du Pont on the possibility of securing patent rights for Orlon is the Toyo Rayon Co. This company is a leading Japanese chemical fibre manufacturer and has proved successful as the first Japanese producer of nylon. It also plans to start production of polyester fibre shortly.

Effect of Boron on Properties of Structural Steels

Boron steel production is considered by Vladimir Keclik in *Hutnicke Listy*, 1957, xii, **8**, 696. The necessity of deoxydation is discussed as well as the necessity of denitration. Research investigations are described when boron was added to steel killed normally and to steel killed by means of a great amount of nitride-forming elements, aluminium, titanium and zirconium. The author of this paper suggests that by addition of boron it is possible to improve some properties of steel especially its through-hardening.

It is also stated that production of boron steels with guaranteed properties leads to some production difficulties, the causes of which have not yet been determined. Also, plasticity of steel is not decreased with boron addition.

US Ethylene Glycol Market

In 1956, US ethylene glycol output was 1,020 million lb. This year output may reach 1,200 million if the production rate for the first seven months is maintained. The first five month's production reached 461.2 million lb., 11 per cent greater than for the same period in 1956.

The antifreeze market is stated to take 78.5 per cent of ethylene glycol production. This year, however, a noticeable feature is the export of ethylene glycol. During the first five months of this year, exports amounted to 70 million lb., with shipments to the UK. Ethylene glycol has also been in demand for Dacron fibre manufacture.

Fertiliser Industry Developments in Israel

A new record phosphates output was achieved in Israel in August with 17,500 metric tons—an increase of 40 per cent over the 12,500 tons produced per month so far.

The potash plant of the Dead Sea Works, it is reported, will reach capacity production in the autumn of next year, after a carnallite reservoir now under construction has been put into use. This reservoir, which will cost I£1 million will make it possible to feed the machines with carnallite 24 hours a day. A large carnallite deposit, five times more concentrated than those found in the Dead Sea, has been discovered recently during oil drilling work on Mount Sodom. A survey is being carried out to ascertain the technical possibilities of its commercial development.

In the first seven months of this year, 60,000 tons of potash were produced by this plant and 53,000 tons were exported, realising $2.4 million; the total revenue derived from the export of potash during 1957 is expected to reach $4 million. More than one-half of the country's total is exported to the UK, with the rest being sent to Australia, Ceylon, Japan and some Latin American States. Israel hopes that the rapid development of the port facilities of Eilat will speed up the development of potash trade with Asiatic countries. However, until bulk loading equipment is available and communications have been improved, the bulk will still be shipped via Haifa.

Apart from the present Sodom plant, proposals for construction of additional potash plants are under consideration; these call for the laying of a pipeline from Sdom to Eilat or to the Mediterranean, through which carnallite will be pumped.

Petrochemicals Represent 26% of US Output Value

At the present time petrochemicals in the US represent 26 per cent of chemical output value, and by 1967 they will form 46 per cent of chemical output value. US sources put the annual growth rate at 15 per cent. Ethylene consumption, now 400 million lb. per year, will reach 550 million by 1961. It is estimated that by this date 26 per cent will be used for ethylene oxide, 26 per cent for polyethylene, 19 per cent for ethanol, 9 per cent for styrene, 7 per cent for ethyl chloride and about 5 per cent for ethylene dichloride.

Propylene output is stated to be growing rapidly. At the present time, production is about 140 million lb. per year. It is believed that polypropylene resins may take 200 million lb. a year of this olefin by 1961. Butadiene is said to be in oversupply with industry capacity at 1.1 million tons level.

In Western Europe petrochemical production, it is suggested, will pass the 1 million tons a year mark in 1959. Present production is about 600,000 tons a year.

Italy's Dyestuff Output Up

Italy's output of synthetic organic dyestuffs rose from 2,338 tons in the first quarter of 1956 to 3,594 tons in the first three months of the current year.

Dominican Republic's Furfural Processing Plant

The only plant which processes sugar cane waste (bagasse) into furfural, situated at La Romana, Dominican Republic, is now in full production. This plant is owned by the South Puerto Rico Sugar Co., and represents an investment of $7 million. Financial success of the venture has been encouraged by the Dominican Government's policy of attracting foreign capital by tax exemptions for the first seven years.

Formosa Titanium Plans

Production of titanium metal is planned by Taiwan Alkali Corp. The project is estimated to cost $2 million (about £750,000). Capacity being considered is of the order of 60 tons of metal a year. Technical assistance will come from the Wah Chang Corporation, New York.

For production of chlorine, there are plans to build an alkali electrolysis plant in Kaohsiung.

Outlook Good for US Sodium Producers

NEXT YEAR, US sodium producers expect a good demand for sodium. An increase of almost 5 per cent over this year is envisaged with prices at a similar level to this year's. But hopes for 1959 are high since high energy fuel intermediates and metal reductions should provide a vast market potential for sodium.

According to a report in *Chemical and Engineering News*, 1957, **35**, No 42, 38, sodium producers are keeping a watchful eye on the titanium market. US Government contracts may be ended or revised in February next year. One US plant, that of Electro Metallurgical's, Ashtabula, Ohio, produces titanium sponge by sodium reduction of titanium tetrachloride. It is estimated that this year this plant will use 36 million lb. of sodium. But at the end of the year, titanium sponge is to be produced by Mallory-Sharon, also at Ashtabula. In full-scale production (plant capacity is 10 million lb. a year) it will use about 40 million lb. of sodium a year. This company also plans a 2 million-lb.-a year zirconium plant which will use 4 million lb. of sodium a year.

Sodium is also associated in the demand for tetraethyl lead. Estimated TEL production (including halogen scavengers) is put at about 750 million lb. for this year.

Production of sodium peroxide, now accounting for about 10 million lb. of sodium a year, is likely to be similar next year, but in 1958, large amounts of sodium will be used by US Industrial Chemicals Inc., in producing isosebacic acid. Very large markets for sodium are likely to be found in the production of high energy fuels such as borohydride. Metal reductions, not only of titanium and zirconium, but also niobium, tantalum and beryllium should also take more sodium. A high purity silicon process, which requires a very pure grade of sodium, is likely to encroach on the sodium field. However, a high grade sodium is reported as not being available at the present time in the US.

Sodium producers in the US are: Du Pont, who expect to complete their Memphis plant next July, adding about 50 per cent to the company's sodium capacity, now estimated at 90 million lb. a year; Ethyl Chemicals with 125 million lb. capacity at their Baton Rouge plant and 100 million lb. at Houston; and US Industrial Chemicals, now producing 60 million lb. and expanding further. Total US sodium capacity for 1958 is estimated therefore at about 415 million lb.

Billingham Division Chairman Warns of Difficulties Ahead

WARNING that despite a period of expansion in which the division was continuing to erect more plants, life was getting more difficult both at home and abroad was made by Mr. W. J. V. Ward, chairman of ICI Billingham division at a recent meeting of the division council. The world had seen a big increase in trade in recent years and there was plenty of opportunity to share in that prosperity; but that would call for their constant attention.

Mr. Ward said that in the fertiliser year from July 1956, new records were made for deliveries of Nitro-chalk and sulphate of ammonia, as well as for the tonnage expressed as total nitrogen. That record was achieved despite a sudden drop in demand which cut short the consuming season in April. The increased stocks in the silos which resulted from that check in sales could have had serious effects on the production programme and a big effort had been needed by sales and distribution to organise an export programme quickly.

In the home market, the division was facing new competitors but they were confident that Nitro-chalk and CCF would sell against the new products. For several years most of Billingham's sulphate of ammonia had been sold in the home market, but with increasing home production there would be more to export.

Industrial Chemicals

Referring to industrial chemicals, Mr. Ward said that the home demand had remained at a high level and showed an advance over last year. Sales of methanol, urea and formaldehyde to the plastics industry had continued good and sales of Drikold had been a record. In addition to growing interest in the delivery of liquid carbon dioxide, Billingham was establishing a business in bulk liquid argon and several customers were using the product.

Competition in overseas markets for industrial chemicals was mounting and the division was having to fight hard to maintain its place. Mr. Ward referred to continuing sales of urea in the US despite rapidly increasing local production and of close attention being given to the possible effect on urea sales to Canada as a result of plans for a manufacturing plant there.

The division was trying to extend markets all the time and business was being captured in places as far apart as Central America, Poland and the Philippines. Sales of anhydrous ammonia in Malaya were being maintained in the face of strong Dutch and German competition. There was a big demand for sodium nitrite in export markets and when the new plant was ready it was hoped to take a greater share of sales. It was hoped to build up a steady market in the US for ammonium bicarbonate despite strong competition.

One of the most striking features in recent years had been the enormous and world-wide expansion in the field of heavy organic chemicals, particularly for making plastics materials and synthetic fibres. The greatest gains in Billingham had been for products for which new plants had been built and he instanced the doubled sales of normal butanol since the start-up of No. 2 carbonylation plant and a 40 per cent increase in ethylene sales since No. 2 olefine plant started up at Wilton. Billingham could also look forward to greater sales of para-xylene and ethylene glycol in view of the planned large expansion of Terylene.

New work mentioned by Mr. Ward as now in progress included the oil gasification plant, which was larger than No. 3 or 4 units, the new CCF plant on the Haverton Hill Road, and the new Nitro-chalk plant at Heysham.

At a long-service dinner on 10 October, Mr. Ward had said that in 1926–27 world production of nitrogen fertilisers was 1,300,000 tons; by 1936–37 it had more than doubled to 2,700,000 tons; for 1955–56, the latest year for which figures were available, total world production was 8,600,000. The rate of increase for other chemicals had been even greater.

New Heat Barrier Stainless Steel

A PATENTED type of stainless steel, stated to be capable of allowing a supersonic aircraft, missile, or even space satellite to pass safely through the heat barrier, has now been perfected by Firth-Vickers Stainless Steels Ltd., of Sheffield.

Known as FV 520, the new steel is the result of intensive research by Firth-Vickers. Besides its use in the aeronautical field it is said to be suitable for a variety of industrial applications.

Claimed to be the only austenitic type of stainless steel hardenable by low temperature heat treatment, principal characteristics of the steel are described as: High tensile and fatigue resistance; stainless properties equivalent to 18/8 steels; resistance to stress corrosion cracking; high resistance to notched impact loads at sub-zero temperatures; weldable; thermal expansion equivalent to mild steel; and 500°C ceiling temperature for service.

A metal capable of withstanding the high frictional temperatures involved at speeds in the 2,000 m.p.h.-plus range is required for space age satellites and missiles. Until now the designer's choice of suitable material was confined chiefly to titanium, which, although offering exceptional qualities of heat resistance, is expensive, difficult to produce and work, and comparatively weak in strength.

According to Firth-Vickers FV 520 provides, for the first time, a stainless steel which combines high strength, low thermal expansion and corrosion resistance. Test samples immersed in sodium chloride for one year were practically unaffected, and other laboratory tests have shown FV 520 to be superior to all other types of stainless steel.

Unlike most stainless steels capable of being heat treated to a relatively high tensile strength, FV 520 has been found to be readily welded without pre-heating. It is reported that no elaborate precautions are needed to avoid cracks and there is no tendency to peak hardening in the heat-affected zones. Maximum hardness adjacent to welds is of the order of 320 Brinell. No heat treatment after welding is required, although a post-weld heat treatment at 550°C may be considered desirable for purposes of stress relief.

FV 520 was developed by Mr. John Morley, Chief Metallurgist of Firth-Vickers.

Material Testing Reactor Now Critical

PLUTO, the latest materials-testing reactor at the Atomic Energy Research Establishment, Harwell, went into operation on 25 October. Pluto was designed and built to provide the intense neutron fluxes which are now required to help advance the authority's reactor research programme.

At full power Pluto will generate a peak neutron flux of 10^{14} neutrons/cm²/sec at a heat output of 10 megawatts. The reactor uses highly enriched uranium as a fuel, and heavy water as both coolant and moderator. Pluto will also be used to produce Cobalt-50 at high activity levels for hospital and industrial use.

The reactor and its associated plant and buildings was designed and constructed by an AERE team in association with the Ministry of Works and Head Wrightson Processes Ltd.

The Ministry of Works carried out the detailed design of the major civil works and services in association with a number of industrial firms.

Among main contractors were W. E. Chivers and Sons Ltd. (civil works); Matthew Hall and Co. Ltd. (mechanical plant); Whessoe Ltd. (airtight building); J. Stone and Co. (Charlton) Ltd. (air lock doors); Andrew Machine Construction Co. Ltd. (ventilation).

Head Wrightson Processes carried out the detailed design and construction of the reactor itself and the following firms were sub-contractors for the larger equipment:

M. and W. Grazebrook Ltd., reactor steel tank and support ring; The APV Co. Ltd., reactor aluminium tank; International Combustion Ltd., aluminium tank top shield, annular shield and fuel element transport flasks; H. M. Hobson Ltd., control equipment; Haywood Tyler and Co. Ltd., heavy water main circulating pumps; Hydraulic and Mechanical Developments Ltd., heavy water auxiliary circulating pumps; Metal Propellers Ltd., heavy water storage vessels; Robert Jenkins and Co. Ltd., experimental facility housings and shielded handling flasks for experimental equipment.

Ashmore, Benson, Pease and Co., helium gasholders, expansion vessel and fabrication of SS pipework; British Oxygen Engineering Co., helium dryer and adsorber; Baker Platinum Ltd., helium recombination unit; The Permutit Co. Ltd., cooling water treatment plant; Thomas Firth and John Brown Ltd., reactor top plate; London Aluminium Co. Ltd., experimental facility thimbles and sleeves; Langley Alloys Ltd., stainless steel heads for experimental facilities; George Kent Ltd., industrial instrumentation; E. K. Cole Ltd., nucleonic instrumentation; Stewarts and Lloyds Ltd., fabrication of cooling water piping; Gwynnes Pumps Ltd., main cooling water pumps; Savage and Parsons Ltd., fuel element plugs; Head, Wrightson and Co. Ltd., heavy water coolers and erection of the reactor; Head, Wrightson Processes Ltd., cooling tower and design and construction of the reactor.

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It is also stated that production of boron steels with guaranteed properties leads to some production difficulties, the causes of which have not yet been determined. Also, plasticity of steel is not decreased with boron addition.

US Ethylene Glycol Market

In 1956, US ethylene glycol output was 1,020 million lb. This year output may reach 1,200 million if the production rate for the first seven months is maintained. The first five month's production reached 461.2 million lb., 11 per cent greater than for the same period in 1956.

The antifreeze market is stated to take 78.5 per cent of ethylene glycol production. This year, however, a noticeable feature is the export of ethylene glycol. During the first five months of this year, exports amounted to 70 million lb., with shipments to the UK. Ethylene glycol has also been in demand for Dacron fibre manufacture.

Fertiliser Industry Developments in Israel

A new record phosphates output was achieved in Israel in August with 17,500 metric tons—an increase of 40 per cent over the 12,500 tons produced per month so far.

The potash plant of the Dead Sea Works, it is reported, will reach capacity production in the autumn of next year, after a carnallite reservoir now under construction has been put into use. This reservoir, which will cost I£1 million will make it possible to feed the machines with carnallite 24 hours a day. A large carnallite deposit, five times more concentrated than those found in the Dead Sea, has been discovered recently during oil drilling work on Mount Sodom. A survey is being carried out to ascertain the technical possibilities of its commercial development.

In the first seven months of this year, 60,000 tons of potash were produced by this plant and 53,000 tons were exported, realising $2.4 million; the total revenue derived from the export of potash during 1957 is expected to reach $4 million. More than one-half of the country's total is exported to the UK, with the rest being sent to Australia, Ceylon, Japan and some Latin American States. Israel hopes that the rapid development of the port facilities of Eilat will speed up the development of potash trade with Asiatic countries. However, until bulk loading equipment is available and communications have been improved, the bulk will still be shipped via Haifa.

Apart from the present Sodom plant, proposals for construction of additional potash plants are under consideration; these call for the laying of a pipeline from Sdom to Eilat or to the Mediterranean, through which carnallite will be pumped.

Petrochemicals Represent 26% of US Output Value

At the present time petrochemicals in the US represent 26 per cent of chemical output value, and by 1967 they will form 46 per cent of chemical output value. US sources put the annual growth rate at 15 per cent. Ethylene consumption, now 400 million lb. per year, will reach 550 million by 1961. It is estimated that by this date 26 per cent will be used for ethylene oxide, 26 per cent for polyethylene, 19 per cent for ethanol, 9 per cent for styrene, 7 per cent for ethyl chloride and about 5 per cent for ethylene dichloride.

Propylene output is stated to be growing rapidly. At the present time, production is about 140 million lb. per year. It is believed that polypropylene resins may take 200 million lb. a year of this olefin by 1961. Butadiene is said to be in oversupply with industry capacity at 1.1 million tons level.

In Western Europe petrochemical production, it is suggested, will pass the 1 million tons a year mark in 1959. Present production is about 600,000 tons a year.

Italy's Dyestuff Output Up

Italy's output of synthetic organic dyestuffs rose from 2,338 tons in the first quarter of 1956 to 3,594 tons in the first three months of the current year.

Dominican Republic's Furfural Processing Plant

The only plant which processes sugar cane waste (bagasse) into furfural, situated at La Romana, Dominican Republic, is now in full production. This plant is owned by the South Puerto Rico Sugar Co., and represents an investment of $7 million. Financial success of the venture has been encouraged by the Dominican Government's policy of attracting foreign capital by tax exemptions for the first seven years.

Formosa Titanium Plans

Production of titanium metal is planned by Taiwan Alkali Corp. The project is estimated to cost $2 million (about £750,000). Capacity being considered is of the order of 60 tons of metal a year. Technical assistance will come from the Wah Chang Corporation, New York.

For production of chlorine, there are plans to build an alkali electrolysis plant in Kaohsiung.

Outlook Good for US Sodium Producers

NEXT YEAR, US sodium producers expect a good demand for sodium. An increase of almost 5 per cent over this year is envisaged with prices at a similar level to this year's. But hopes for 1959 are high since high energy fuel intermediates and metal reductions should provide a vast market potential for sodium.

According to a report in *Chemical and Engineering News*, 1957, **35**, No 42, 38, sodium producers are keeping a watchful eye on the titanium market. US Government contracts may be ended or revised in February next year. One US plant, that of Electro Metallurgical's, Ashtabula, Ohio, produces titanium sponge by sodium reduction of titanium tetrachloride. It is estimated that this year this plant will use 36 million lb. of sodium. But at the end of the year, titanium sponge is to be produced by Mallory-Sharon, also at Ashtabula. In full-scale production (plant capacity is 10 million lb. a year) it will use about 40 million lb. of sodium a year. This company also plans a 2 million-lb.-a year zirconium plant which will use 4 million lb. of sodium a year.

Sodium is also associated in the demand for tetraethyl lead. Estimated TEL production (including halogen scavengers) is put at about 750 million lb. for this year.

Production of sodium peroxide, now accounting for about 10 million lb. of sodium a year, is likely to be similar next year, but in 1958, large amounts of sodium will be used by US Industrial Chemicals Inc., in producing isosebacic acid. Very large markets for sodium are likely to be found in the production of high energy fuels such as borohydride. Metal reductions, not only of titanium and zirconium, but also niobium, tantalum and beryllium should also take more sodium. A high purity silicon process, which requires a very pure grade of sodium, is likely to encroach on the sodium field. However, a high grade sodium is reported as not being available at the present time in the US.

Sodium producers in the US are: Du Pont, who expect to complete their Memphis plant next July, adding about 50 per cent to the company's sodium capacity, now estimated at 90 million lb. a year; Ethyl Chemicals with 125 million lb. capacity at their Baton Rouge plant and 100 million lb. at Houston; and US Industrial Chemicals, now producing 60 million lb. and expanding further. Total US sodium capacity for 1958 is estimated therefore at about 415 million lb.

Billingham Division Chairman Warns of Difficulties Ahead

WARNING that despite a period of expansion in which the division was continuing to erect more plants, life was getting more difficult both at home and abroad was made by Mr. W. J. V. Ward, chairman of ICI Billingham division at a recent meeting of the division council. The world had seen a big increase in trade in recent years and there was plenty of opportunity to share in that prosperity; but that would call for their constant attention.

Mr. Ward said that in the fertiliser year from July 1956, new records were made for deliveries of Nitro-chalk and sulphate of ammonia, as well as for the tonnage expressed as total nitrogen. That record was achieved despite a sudden drop in demand which cut short the consuming season in April. The increased stocks in the silos which resulted from that check in sales could have had serious effects on the production programme and a big effort had been needed by sales and distribution to organise an export programme quickly.

In the home market, the division was facing new competitors but they were confident that Nitro-chalk and CCF would sell against the new products. For several years most of Billingham's sulphate of ammonia had been sold in the home market, but with increasing home production there would be more to export.

Industrial Chemicals

Referring to industrial chemicals, Mr. Ward said that the home demand had remained at a high level and showed an advance over last year. Sales of methanol, urea and formaldehyde to the plastics industry had continued good and sales of Drikold had been a record. In addition to growing interest in the delivery of liquid carbon dioxide, Billingham was establishing a business in bulk liquid argon and several customers were using the product.

Competition in overseas markets for industrial chemicals was mounting and the division was having to fight hard to maintain its place. Mr. Ward referred to continuing sales of urea in the US despite rapidly increasing local production and of close attention being given to the possible effect on urea sales to Canada as a result of plans for a manufacturing plant there.

The division was trying to extend markets all the time and business was being captured in places as far apart as Central America, Poland and the Philippines. Sales of anhydrous ammonia in Malaya were being maintained in the face of strong Dutch and German competition. There was a big demand for sodium nitrite in export markets and when the new plant was ready it was hoped to take a greater share of sales. It was hoped to build up a steady market in the US for ammonium bicarbonate despite strong competition.

One of the most striking features in recent years had been the enormous and world-wide expansion in the field of heavy organic chemicals, particularly for making plastics materials and synthetic fibres. The greatest gains in Billingham had been for products for which new plants had been built and he instanced the doubled sales of normal butanol since the start-up of No. 2 carbonylation plant and a 40 per cent increase in ethylene sales since No. 2 olefine plant started up at Wilton. Billingham could also look forward to greater sales of para-xylene and ethylene glycol in view of the planned large expansion of Terylene.

New work mentioned by Mr. Ward as now in progress included the oil gasification plant, which was larger than No. 3 or 4 units, the new CCF plant on the Haverton Hill Road, and the new Nitro-chalk plant at Heysham.

At a long-service dinner on 10 October, Mr. Ward had said that in 1926–27 world production of nitrogen fertilisers was 1,300,000 tons; by 1936–37 it had more than doubled to 2,700,000 tons; for 1955–56, the latest year for which figures were available, total world production was 8,600,000. The rate of increase for other chemicals had been even greater.

New Heat Barrier Stainless Steel

A PATENTED type of stainless steel, stated to be capable of allowing a supersonic aircraft, missile, or even space satellite to pass safely through the heat barrier, has now been perfected by Firth-Vickers Stainless Steels Ltd., of Sheffield.

Known as FV 520, the new steel is the result of intensive research by Firth-Vickers. Besides its use in the aeronautical field it is said to be suitable for a variety of industrial applications.

Claimed to be the only austenitic type of stainless steel hardenable by low temperature heat treatment, principal characteristics of the steel are described as: High tensile and fatigue resistance; stainless properties equivalent to 18/8 steels; resistance to stress corrosion cracking; high resistance to notched impact loads at sub-zero temperatures; weldable; thermal expansion equivalent to mild steel; and 500°C ceiling temperature for service.

A metal capable of withstanding the high frictional temperatures involved at speeds in the 2,000 m.p.h.-plus range is required for space age satellites and missiles. Until now the designer's choice of suitable material was confined chiefly to titanium, which, although offering exceptional qualities of heat resistance, is expensive, difficult to produce and work, and comparatively weak in strength.

According to Firth-Vickers FV 520 provides, for the first time, a stainless steel which combines high strength, low thermal expansion and corrosion resistance. Test samples immersed in sodium chloride for one year were practically unaffected, and other laboratory tests have shown FV 520 to be superior to all other types of stainless steel.

Unlike most stainless steels capable of being heat treated to a relatively high tensile strength, FV 520 has been found to be readily welded without pre-heating. It is reported that no elaborate precautions are needed to avoid cracks and there is no tendency to peak hardening in the heat-affected zones. Maximum hardness adjacent to welds is of the order of 320 Brinell. No heat treatment after welding is required, although a post-weld heat treatment at 550°C may be considered desirable for purposes of stress relief.

FV 520 was developed by Mr. John Morley, Chief Metallurgist of Firth-Vickers.

Material Testing Reactor Now Critical

PLUTO, the latest materials-testing reactor at the Atomic Energy Research Establishment, Harwell, went into operation on 25 October. Pluto was designed and built to provide the intense neutron fluxes which are now required to help advance the authority's reactor research programme.

At full power Pluto will generate a peak neutron flux of 10^{14} neutrons/cm²/sec at a heat output of 10 megawatts. The reactor uses highly enriched uranium as a fuel, and heavy water as both coolant and moderator. Pluto will also be used to produce Cobalt-50 at high activity levels for hospital and industrial use.

The reactor and its associated plant and buildings was designed and constructed by an AERE team in association with the Ministry of Works and Head Wrightson Processes Ltd.

The Ministry of Works carried out the detailed design of the major civil works and services in association with a number of industrial firms.

Among main contractors were W. E. Chivers and Sons Ltd. (civil works); Matthew Hall and Co. Ltd. (mechanical plant); Whessoe Ltd. (airtight building); J. Stone and Co. (Charlton) Ltd. (air lock doors); Andrew Machine Construction Co. Ltd. (ventilation).

Head Wrightson Processes carried out the detailed design and construction of the reactor itself and the following firms were sub-contractors for the larger equipment:

M. and W. Grazebrook Ltd., reactor steel tank and support ring; The APV Co. Ltd., reactor aluminium tank; International Combustion Ltd., aluminium tank top shield, annular shield and fuel element transport flasks; H. M. Hobson Ltd., control equipment; Haywood Tyler and Co. Ltd., heavy water main circulating pumps; Hydraulic and Mechanical Developments Ltd., heavy water auxiliary circulating pumps; Metal Propellers Ltd., heavy water storage vessels; Robert Jenkins and Co. Ltd., experimental facility housings and shielded handling flasks for experimental equipment.

Ashmore, Benson, Pease and Co., helium gasholders, expansion vessel and fabrication of SS pipework; British Oxygen Engineering Co., helium dryer and adsorber; Baker Platinum Ltd., helium recombination unit; The Permutit Co. Ltd., cooling water treatment plant; Thomas Firth and John Brown Ltd., reactor top plate; London Aluminium Co. Ltd., experimental facility thimbles and sleeves; Langley Alloys Ltd., stainless steel heads for experimental facilities; George Kent Ltd., industrial instrumentation; E. K. Cole Ltd., nucleonic instrumentation; Stewarts and Lloyds Ltd., fabrication of cooling water piping; Gwynnes Pumps Ltd., main cooling water pumps; Savage and Parsons Ltd., fuel element plugs; Head, Wrightson and Co. Ltd., heavy water coolers and erection of the reactor; Head, Wrightson Processes Ltd., cooling tower and design and construction of the reactor.

PEOPLE in the news

● Metropolitan-Vickers Electrical Co. Ltd. announce the appointment of MR. H. B. GOUGH, Assoc.I.E.E., M.S.X-Ray T., as sales manager, scientific apparatus and X-ray departments, and MR. G. F. GRIBBIN, B.Sc., A.M.I.E.E., is appointed assistant sales manager of the X-ray department in London. These appointments follow the recent retirement of MR. J. W. BUCKLEY, formerly sales manager, scientific apparatus department.

● North regional manager for ICI, MR. T. CON FAWCETT, retired at the end of last month. Mr. Fawcett spent 12 years in Manchester as the regional manager. He is chairman of the chemical and allied trades sections, Manchester Chamber of Commerce.

● Leaving this country on the 18 November to visit East and West Africa, MR. J. D. MAY, export sales manager of George Kent Ltd., will be meeting customers and agents in these territories to discuss and study the possibilities for future sales expansion of the firm's products. Flying first to Nairobi, Mr. May will later go on to Uganda and Tanganyika before travelling to Angola, Nigeria and Ghana in December.

● MR. S. M. H. JAFRI, a 25-year-old B.Sc., has just arrived in Bradford from Karachi, where he left his job in a textile mill in order to take a diploma course in dyeing at the Bradford Institute of Technology. His training is sponsored by the technical co-operation scheme of the Colombo Plan, which aims to develop the backward areas of the world. On his return Mr. Jafri will help to raise the standard of textile production in his own country.

● MR. WILLIAM HENRY HOUGH, engineering services manager of ICI's salt division, Northwich, has retired after 48 years in the salt industry. He began his career with Salt Brim Ltd., which in 1937 was taken over by ICI.

● MR. T. C. BOWER, general manager of Procter and Gamble, France SA, since 1955, has now been appointed an associate director in the overseas division of Procter and Gamble with responsibility for the companies in France, Belgium and Italy.

● MR. H. SHAW has been appointed division technical director of the ICI general chemicals division, and MR. G. E. SUTTON, who will remain the division's chief accountant, has been appointed division finance director. Mr. Shaw was born in 1904, and educated at Manchester University, where he obtained both a B.Sc. and an M.Sc. Mr. Shaw joined the research department of general chemicals division's Castner-Kellner Works in 1927, and in 1932 was appointed a deputy manager of the division's technical service department and during this appointment he spent one year in Australia. In 1942, he became works manager of the Rocksavage Works near Runcorn, and in 1946 works manager of Castner-Kellner Works. During 1945, Mr. Shaw spent some time in Germany as a member of a technical investigation team and he has made many trips to the US. Mr. Sutton was born in 1902, and joined one of the company's predecessors as an office boy in 1917. By 1928 he had become a works secretary, and in 1931 was appointed deputy works accountant of general chemicals division's Vassell Works at Billingham. During the last war, he served as deputy accountant with the operations department of the Ministry of Supply, and on his return to ICI he became assistant division chief accountant at general chemicals divisional h.q. in Liverpool. He became division chief accountant on 1 July 1951.

● DR. E. SWINDLEHURST, technical officer of T. Wall and Sons Ltd., ice cream manufacturers, has joined the board of the company as technical director.

● The British Aluminium Company Limited announce that MR. P. S. W. SWABEY has been appointed assistant general sales manager with effect from 1 November 1957.

● MR. M. SEAMAN, having recently become director and general manager of British Oxygen Gases Ltd. (equipment division) has relinquished his appointment as director and general manager of British Oxygen Engineering Ltd.

● MR. R. J. FOSTER, formerly general manager, has now been appointed director and general manager of British Oxygen Aro Equipment Ltd.

● MR. VICTOR LAMBERT and MR. J. B. SOMERVAIL, who will be covering the south of England, are two new representatives in the laboratory, scientific and industrial division of James A. Jobling and Co. Ltd. They will be based on Jobling's London office at 81 Cromwell Road.

● MR. R. W. MONEY won the Monsanto Cup at the autumn golf meeting of the London section, Royal Institute of Chemistry, with a score of 67. The runner-up was MR. R. FALCONER. In the afternoon round, playing against bogey, MR. J. W. WATSON and MR. I. ROSE returned a winning score of 2-up and were followed by MR. R. W. MONEY and MR. J. M. J. WADIA with 1-up on bogey. The Monsanto Cup was presented by DR. C. C. HALL, section chairman; other prizes were presented by DR. H. G. SMITH.

● MR. K. H. HANDY, an area manager at Ruabon for Monsanto Chemicals Ltd., has been appointed works manager of the company's new Fawley factory. MR. K. C. BRYANT, who joined Monsanto in 1949 and is research manager of the polythene project group at Fulmer Hall, has been appointed laboratory manager at Fawley. MR. A. C. W. PEMBERTON, manager of the DDB, oil additives and HCL group at Newport, Mon, becomes Fawley production manager. MR. F. J. ROBERTS, construction engineer, site agent, at Fawley, has been appointed maintenance manager. These appointments will take effect over the next few months.

● MR. W. J. WORBOYS, commercial director, Imperial Chemical Industries, has been elected an honorary fellow of Lincoln College, Oxford. Mr. Worboys is president of the Association of British Chemical Manufacturers.

● MR. H. F. ROBERTSON has been appointed technical director of Union Carbide Development Co., division of Union Carbide Corporation, US.

Obituary

MR. GEORGE FRANCIS NEW, O.B.E., Ph.D., F.Inst.P., died on 15 October in a Madrid hospital, aged 63. Dr. New was well known in the paint industry, when in 1927 he joined the Paint Research Station as chief physicist. In 1934 he left the station to join British Titan Products Co. Ltd. as development manager.

During World War II he was seconded to the National Paint Federation to deal with war-time distribution of raw materials to the paint industry. After the war Dr. New became general manager and secretary of the Fertiliser Manufacturers' Association, and secretary of the Fertiliser Society. He also became secretary of the Superphosphate Manufacturers' Association. He was in Madrid in connection with an international superphosphate conference when he died.

The International Nickel Co. of Canada, Ltd. report the death of DR. PAUL D. MERICA in New York on 20 October 1957.

Dr. Merica first became associated with International Nickel in 1919, becoming director of research and subsequently assistant manager of the development and research department. He became assistant to the president in 1932, a director in 1934, vice-president in 1936, executive vice-president in February 1949, and president in May 1952, retiring from the last position in April 1954.

Dr. Merica continued to serve the company on important projects and as consultant to the officers. He also continued as a director of The International Nickel Co. of Canada, Ltd., and its US subsidiary, The International Nickel Co., Inc.

Commercial News

British Chrome and Brotherton Announce Merger Plans

AS a result of discussions between the directors of British Chrome and Chemicals (Holdings) and of Brotherton and Co., with a view to a merger, arrangements have now been agreed in principle for recommendation to the respective shareholders.

It is intended that the merger will be effected through the medium of British Chrome as this company is already a holding company, and an appropriate change of name will be made.

In a joint announcement, it is stated that the amalgamation takes the form of an exchange of shares on the basis of two British Chrome 5s. ordinary units for each Brotherton 10s. ordinary share, and of one British Chrome 6 per cent £1 preference for each Brotherton 6 per cent £1 preference. British Chrome has £262,250 preference and £1,039,164 ordinary issue. Brotherton's issued capital is £250,000 in preference and £1,025,000 ordinary.

Holders in each company are to receive this month documents containing the full terms and other information.

British Alkaloids

An interim dividend of 1.2d. per 10s. share for the year ending 31 March, 1958 (same), has been declared by British Alkaloids Ltd.

The board reports that sales for the first six months to 30 September, 1957, show a satisfactory increase compared with the same period of 1956. Also, owing to the spread of Asian 'flu since the turn of the year, sales have been running at a record level.

Courtaulds Ltd.

Because of lower profits for the first half year, Courtaulds Ltd., are reducing their interim dividend from 4 per cent to 3 per cent. Following the merger with British Celanese, on a share exchange basis, the interim is payable on some £5 million more ordinary.

The board is of the opinion, in view of the outlook for the remainder of the year, that unless there is a substantial improvement in trading conditions, the profits of the group which now includes British Celanese, will this year be 'significantly less' than the combined profits of the two companies for the year ended 31 March 1957. At that time, when there was a fall of £3 million in revenue, the dividend total was repeated at 10 per cent with a 6 per cent final.

Shareholders have been informed that during the first half of the current year, business in textile yarns, both viscose and acetate, was affected by trading conditions and, despite the increase in home market prices of such yarns early this year, profits were reduced.

The present statement ends with the note that in its impending review of plans for capital expenditure, the board will take fully into consideration general financial and economic conditions in the UK.

Fisons Ltd.

Current dividend by Fisons Ltd., which is to be paid on 13 December, is 10 per cent (same). Total dividend paid last year was 15 per cent.

Group trading profits for the year ended 30 June last rose to £4,365,068 from £4,190,405 for 1955–56. Net profits are £1,516,413 against £1,238,762, after depreciation of £1,013,086 (£993,445), interest charges of £257,091 (£145,691), tax of £1,568,224 (£1,557,223), and minority interests of £11,060 (£5,284 and amount written off investment in associate company of £250,000).

Olin Mathieson

To provide additional working capital needed in connection with the development of business during the next few years, Olin Mathieson Chemical Corporation, New York, US, intend to sell $60 million of subordinate debentures which will be convertible into common stock. It is also proposed to increase authorised common stock from 15 million to 20 million shares.

Savory and Moore

Manufacturing and retail chemists, Savory and Moore Ltd., are raising their ordinary dividend from 10 per cent to 15 per cent for the year to 31 March 1957. Group trading profits increased from £164,782 to £184,388.

Smith and Nephew

It is announced that negotiations have been opened with a view to the possible merger of Southalls (Birmingham) with Smith and Nephew Associated Cos. Shareholders have been advised not to sell until it is possible to make a further statement.

Vokes Ltd.

Vokes Ltd., manufacturers of air and oil filters, are paying a final dividend of 12½ per cent plus a 5 per cent bonus, making 25 per cent for the year to 30 June 1957, on £450,000 ordinary capital. Similar payments were made for 1955–56, but the interim then was on £300,000.

Group profits have risen from £342,199 to £414,530, but the increase has been offset by heavier tax charges. Net profit is £165,302 compared with £157,175 for the previous year.

United Glass Bottle

An interim statement issued by the directors of United Glass Bottle Manufacturers announces that profits for the first half of this year were very much reduced compared with the first half of 1956.

Although trading conditions have continued to be difficult, the recent increase in selling price is stated to have brought about a recovery in profit margins. Indications at present, however, suggest that in the absence of some improvement over the remainder of the year, the total profits of the company earned in 1957 will show a marked reduction as compared with those in the previous year.

NEW COMPANIES

LETCHWORTH PHARMACEUTICALS LTD. Cap. £1,000 in £1 shares. Manufacturing, analytical, consulting, pharmaceutical and general chemists. Directors: B. G. Cox, Letchworth, Herts (director of Cox's Estates Ltd.). B. D. Handel, Highfield House, Hitchin Road, Letchworth (director of Guild of Nature Paths Osteopaths Ltd.). Secretary: A. C. Glennerster. Reg. office: 5 Leys Avenue, Letchworth, Herts.

RICHD. HUMBLE AND SON LTD. Cap. £5,000 in £1 shares. Oil and grease manufacturers and blenders, previously Richard Humble (Holdings) Ltd., Leeds. Directors: R. N. Duckett, F. N. Duckett, K. Duckett. Reg. office: 13 Kirkstall Road, Leeds, 3.

STERIJAB LTD. Cap. £100 in £1 shares. Manufacturers of and dealers in chemicals, gases, drugs, etc. Directors: Harold E. Bell (director of Ampins Ltd.); and Joan French-Williams. Reg. office: 10 Hay Hill, Berkeley Square, London W1.

INCREASES OF CAPITAL

D. MCDERMOTT (CHEMICALS) LTD., 31 Gladstone Street, Widnes. Increased by £6,000, in £1 preference shares, beyond the registered capital of £8,000.

L. E. PRITCHITT AND CO. LTD. (chemical merchants, etc.), 78 Queen Victoria Street, London EC4. Increased by £98,000, in £1 ordinary shares, beyond the registered capital of £2,000.

TURNERS ASBESTOS CEMENT CO. LTD., Asbestos House, 77–9 Fountain Street, Manchester 2. Increased by £11,999,900, in £1 ordinary shares, beyond the registered capital of £100.

WASHINGTON CHEMICAL CO. LTD., Asbestos House, 77–9 Fountain Street, Manchester 2. Increased by £2,999,900, in £1 ordinary shares, beyond the registered capital of £100.

CHANGES OF NAME

J. A. (BANK STREET) LTD., rubber reclaimers and chemical manufacturers, etc., Bank Street Chemical Works, Clayton, have changed their name to Joseph Anderson and Sons Ltd.

JOSEPH ANDERSON AND SONS LTD., reclaiming rubber, manufacturers of carbon bisulphate, etc., Bank Street Chemical Works, Clayton, Manchester 11, have changed their name to J. A. (Bank Street) Ltd.

LLOYD'S ADRENALINE PRODUCTS LTD., 4 New Burlington Street W1. Name changed to Lloyds' Research Ltd.

HUFFER AND SMITH LTD., New Era Works, Purley Way, Croydon, Surrey, have changed their name to Purley Way Chemicals Ltd.

TRADE NOTES

Hilton and Tuck Ltd., electro-deposition engineers, Hardings Street, Pendleton, Manchester, have had plans approved for the erection of a factory on a site at Floats Road, Baguley, Manchester.

British Aluminium Co.

The British Aluminium Co. Ltd. have transferred their Midland branch sales office from its present address at Lansdowne House, 41 Water Street, Birmingham 3, to 109 Hagley Road, Edgbaston, Birmingham 16. Tel.: Edgbaston 4521. Telegrams: Britalumin Birmingham 16.

Colour Sprays Ltd.

Works and offices of Colour Sprays Ltd., manufacturers of Spray painting equipment, air compressor plants and fume exhaust systems have been moved to Albion Works, North Road, London N7. Tel. North 6091/4.

New Sulphuric Acid Plant

To meet the increased demand for sulphuric acid at their works at Eaglescliffe, near Stockton-on-Tees, British Chrome and Chemicals Ltd. have placed an order with the Power-Gas Corporation Ltd. for a new contact plant with an output of 100 tons/day H_2SO_4 in the form of 95 per cent and 70 per cent strengths. Elemental sulphur will be the raw material employed.

This plant will be built to the design of Chemiebau Dr. A. Zieren G.m.b.H. who co-operate with the Power-Gas Corporation for the installation of sulphuric acid plants in this country and abroad.

Pulsometer Engineering

The Pulsometer Engineering Co. Ltd., of Reading, have acquired the controlling interest in G. S. Tett and Co. Ltd., water softener consultants and manufacturers, of Bedfont Lane, Feltham, Middlesex. Mr. F. B. Duncan, chairman, and Mr. J. S. Woodrow, managing director, of Pulsometer have joined the board of G. S. Tett and Co. Ltd.

Liquid Systems' Order

An order has been placed with Liquid Systems Ltd., Norwich Union House, Wellesley Road, Croydon, for the lubrication of the acrylic fibre plant being designed and built by Constructors John Brown Ltd., for Chemstrand Ltd. in Northern Ireland. The machines, which have been subcontracted to Baker-Perkins Ltd., will produce 10 million lb. of Acrilan fibre per year and will be lubricated by 5 to 25 g.p.m. and 4 to 5 g.p.m. Bowser lubricating systems.

Marchon Australian Agents

Marchon Products Ltd., Whitehaven, Cumberland, have modified their representation in Australia. John Beith and Co. Pty. Ltd., Union House, George Street, Sydney NSW, who also have offices in Melbourne and Brisbane, will continue to handle Marchon's Nansa and Empicol products—alkyl aryl sulphonates and fatty alcohol sulphates. Marchon's associated company, Albright and Wilson (Australia) Pty Ltd., 101 Hawke Street, West Melbourne C3, who also have offices in Sydney, will be responsible for all other Marchon products sold in Australia, including surface active agents and detergent raw materials sold under the trade names of Empilan, Empimin and Laurex.

Smith and Nephew

The plastics department of Smith and Nephew Associated Companies has been turned into a limited company—Smith and Nephew Plastics—with a capital of £50,000.

Wakefield to Market Chemicals

Large-scale producers of chemical additives for their own lubricating oils (Castrol), C. C. Wakefield and Co. now intend to manufacture and market other chemical products not necessarily connected with lubricants. Marketing of the group's chemical products will be through the member company, Edwin Cooper and Co., 43 Grosvenor Street, London W, under Mr. L. M. Broadway as chairman, Mr. W. Helmore as deputy chairman, and Mr. G. H. Thornley as managing director.

US offers OEEC $0.5 m. for Training Scientists

AN OEEC working party on scientific and technical manpower was informed last Saturday by a member of the US delegation to the party of a US Government offer to contribute $500,000 to OEEC in the current financial year for the training of West European scientists and technicians. The offer is conditional 'to a joint fund being set up to which participating European countries would make an equivalent contribution'. This fund would enable the organisation to set its scientific and technical manpower programme on a firm basis.

In May this year an OEEC report was published about shortage of highly trained technicians in Western Europe. It was suggested in the report that a concerted approach should be made to the problem by the 17 member countries.

FOR YOUR DIARY

MONDAY, 4 NOVEMBER

Manchester Federation of Scientific Societies—Manchester; Engineers' Club, Albert Square, 7 p.m. 'Application of nuclear power in industry'.

Society of Chemical Industry, Food Group—London; Joint meeting with London section, 14 Belgrave Square, SW1. 6.15 p.m. 'Technological and analytical problems involved in the use of food additives'.

TUESDAY, 5 NOVEMBER

Society for Analytical Chemistry—London; Royal Institution, 21 Albemarle Street, W1. 6.30 p.m. 'Recent developments in chelatometry' by Dr. R. Pribil.

Institution of Chemical Engineers—London; Geological Society, Burlington House, W1. 5.30 p.m. 'An education for our times!' by Dr. R. P. Linstead.

SCI Plastics and Polymer Group—London; 14 Belgrave Square, SW1. 6.30 p.m. 'Synthetic polypeptides as protein models' by Dr. C. H. Bamford.

WEDNESDAY, 6 NOVEMBER

North-Western Fuel Luncheon Club—Manchester; Engineers' Club, Albert Square. 12.15 p.m. 'Relationship between technological education and industry' by E. J. Dunstan.

Institute of Welding—Manchester; Reynolds Hall, College of Science and Technology. 7.15 p.m. 'Ultrasonic testing of welds' by J. Johnson.

British Institute of Management—Bournemouth; National Management Conference. Till Friday, 8 November.

THURSDAY, 7 NOVEMBER

RIC, London Section—Acton; Brunel College of Technology, Woodlands Avenue, W3. 6.30 p.m. 'Some new instruments developed at Harwell' by R. Spence.

CS and SCI Fine Chemicals Group—London; Chemistry Dept., University College, Gower Street, WC1. 2.15 p.m.–7 p.m. Symposium, 'Newer preparative methods in organic chemistry'.

Royal Society—London; Burlington House, Piccadilly, W1. 4.30 p.m. 'Virus-host cell interactions' by Wilson Smith.

FRIDAY, 8 NOVEMBER

Plastics Institute, NW Section and Liverpool Section of Institution of Rubber Industry—Liverpool; Exchange Hotel. 7.15 p.m. 'P.v.c.' by A. Hill.

Dunlop Awards

Examination awards of more than £800 in all have been made by Dunlop Rubber Co. to 80 of their employees, including 11 awards worth £135 to students of chemistry, and 12 awards worth £140 to physics students.

Market Reports

EASING-UP IN FORWARD BUSINESS

LONDON The volume of trading on the industrial chemicals market during the past week has been satisfactory for routine potash and soda products. Most other lines are moving steadily with a slight easing off in new forward business. Demand for fertilisers has been maintained on a good level. Prices throughout are more or less unchanged with a firm undertone continuing.

The coal-tar products market is again without feature with most items finding a ready outlet.

MANCHESTER Some of the industrial outlets for heavy chemicals, partly because of seasonal factors, are absorbing somewhat smaller quantities, but on the whole the aggregate movement into consumption against contracts in Lancashire and the West Riding keeps up reasonably well. A fairly steady demand on export account is also reported. New enquiry has been on a fair scale. Quotations generally are on a firm basis. In basic slag and one or two other sections of the fertiliser trade the demand is on steady lines, and fair activity is reported in most of the tar products.

GLASGOW After a quiet opening, conditions improved during the week in the Scottish heavy chemical market, and towards the end a much more active position prevailed. The chemicals demanded were mostly nominal current requirements of industry. Prices on the whole showed little or no change. The position of exports is still favourable, with the usual varied range of enquiries.

UK Chemical Exports and Imports for January-Sept 1957

EXPORTS

		QUANTITY		VALUE	
		Jan./Sept. 1956	Jan./Sept. 1957	Jan./Sept. 1956	Jan./Sept. 1957
INORGANIC				£	£
Acids	Cwt.	141,719	156,309	486,426	500,905
Copper sulphate	Tons	38,272	26,333	4,033,666	2,306,350
Sodium hydroxide	Cwt.	4,011,284	3,366,341	5,118,072	4,309,071
Sodium carbonate	,,	3,714,297	3,382,766	2,283,518	2,318,656
Aluminium oxide	Tons	19,232	23,782	628,448	833,734
Aluminium sulphate	,,	31,411	25,495	448,617	360,258
Other aluminium cpds.	,,	2,507	2,969	102,846	123,365
Ammonia	Cwt.	73,854	60,569	273,961	234,572
Ammonium cpds. (not fertilisers or bromide)	Tons	17,259	14,003	660,639	543,109
Arsenical compounds	,,	3,292	3,163	250,290	223,686
Bismuth compounds	Lb.	234,877	270,774	200,536	225,221
Bleaching powder (chloride of lime)	Cwt.	275,785	172,819	454,108	303,246
Hydrosulphite	,,	53,677	67,262	427,941	526,925
Other bleaching materials	,,	79,452	104,991	353,102	490,519
Calcium compounds	,,	251,278	258,282	510,760	509,620
Carbon blacks	,,	318,751	565,779	1,103,590	2,054,401
Cobalt compounds	,,	9,875	11,599	447,823	412,916
Iron oxides (chemically manufactured)	,,	73,141	73,789	237,274	223,123
Lead compounds	,,	33,262	40,311	224,547	246,769
Magnesium compounds (nes)	Tons	9,241	13,879	498,398	662,746
Nickel salts	Cwt.	56,841	62,699	547,299	683,381
Potassium cpds. (not fertilisers or bromides)	,,	39,709	42,678	385,428	430,718
Sodium bicarbonate	,,	549,700	562,896	490,688	518,658
Sodium phosphates	,,	54,455	97,879	260,103	456,308
Sodium silicate (water glass)	,,	300,865	248,639	262,152	224,825
Other sodium cpds.	,,	1,257,470	1,270,981	2,805,002	2,902,417
Tin oxide	,,	5,593	6,527	204,742	238,646
Zinc oxide	Tons	4,168	4,984	338,095	356,502
Inorganic chemicals (nes)		—	—	3,555,655	3,559,586
ORGANIC					
Acids, anhydrides and their salts and esters		—	—	994,983	963,337
Glycerine	Cwt.	40,495	78,123	453,452	721,103
Ethyl alcohol, etc., and mixtures of alcohols (nes)		—	—	957,963	1,146,170
Acetone	Cwt.	143,916	91,938	361,197	296,940
Citric acid	,,	26,000	38,118	256,529	372,074
Gases, compressed, liquid or solid (nes)		—	—	739,086	1,778,385
Phenol	Cwt.	65,446	98,185	416,525	635,760
Salicylates	Lb.	614,282	814,105	165,087	233,899
Sodium compounds	Cwt.	19,626	23,066	221,926	298,391
Sulphonamides, not prepared	Lb.	1,181,881	1,050,891	648,761	750,414
Dyestuffs intermediates (nes)	Cwt.	58,897	76,897	1,026,071	1,101,935
Organic compounds (nes)		—	—	10,070,039	12,482,351
Total for elements & cpds.		—	—	**43,985,345**	**47,560,992**
Coal tar	Tons	97,483	74,735	895,591	799,884
Cresylic acid	Gall.	2,876,422	2,354,050	914,841	865,935
Benzol	,,	672,447	17,756	119,648	7,384
Creosote oil	,,	17,173,010	14,300,816	1,112,193	966,770
Other mineral tar and crude chemicals		—	—	3,512,609	2,977,554
Pigment dyestuffs	Cwt.	17,701	21,158	742,157	852,073
Other synthetic dyestuffs	,,	139,990	147,036	6,247,650	7,156,288
Synthetic organic pigments	,,	16,885	18,874	598,056	755,900
Vegetable and animal dyeing extracts	,,	2,984	2,755	100,016	95,725
Tanning extracts	,,	77,252	99,207	342,449	442,278
Synthetic tanning materials	,,	52,389	60,314	185,446	229,657
Pigments, paints and varnishes		—	—	17,379,319	18,056,488
Drugs, medicines, etc.		—	—	26,080,973	29,731,578
Explosives		—	—	7,989,161	8,110,085
Insecticides, fungicides and rodenticides	Cwt.	285,538	262,540	3,269,108	3,312,224
Weedkillers	,,	70,897	78,259	839,539	848,235
Carbons, decolourising or activated	,,	71,772	61,621	301,050	259,604
Tetra-ethyl lead anti-knock compound	Gall.	3,640,824	4,152,326	7,787,730	9,062,673
FERTILISERS					
Ammonium nitrate	Tons	3,088	1,823	99,339	60,242
Ammonium sulphate	,,	21,133	108,071	409,592	1,893,620
Phosphatic and potassic		—	—	51,029	51,536
Other fertilisers		—	—	279,654	281,715
PLASTICS MATERIALS					
Phenol and cresol formaldehyde resins	Cwt.	45,929	51,964	326,384	354,097
Urea formaldehyde resins	,,	196,040	171,823	938,122	865,207
Vinyl resins, unplasticised	,,	110,435	154,226	1,093,189	1,349,114
Vinyl resins, plasticised	,,	80,150	97,084	1,043,778	1,166,395
Other vinyl resins	,,	137,673	159,822	1,713,268	2,059,539
Moulding materials	,,	546,195	700,746	6,951,246	9,092,186
Sheet, rod, tube, film and foil	,,	201,586	224,638	6,635,690	6,894,343

IMPORTS

		QUANTITY		VALUE	
		Jan./Sept. 1956	Jan./Sept. 1957	Jan./Sept. 1956	Jan./Sept. 1957
INORGANIC				£	£
Acids	Cwt.	47,034	48,922	138,349	151,507
Aluminium oxide—					
Crude, unground	Tons	18,070	13,926	941,713	760,794
Ground or graded	,,	2,457	2,204	259,915	239,309
Silicon carbide	,,	9,965	7,040	1,014,261	708,663
Arsenic trioxide	,,	4,291	2,877	149,771	84,970
Borax, refined	Cwt.	345,101	360,540	651,644	725,143
Calcium carbide	,,	723,280	867,230	1,328,513	1,662,455
Carbon black channel	,,	123,631	134,020	697,291	763,676
Other carbon blacks	,,	64,863	57,926	249,940	220,068
Cobalt oxides	,,	11,215	5,316	701,519	332,471
Iodine	Lb.	448,665	739,817	224,715	285,267
Mercury	,,	1,212,489	1,178,631	1,327,819	1,291,708
Sodium, calcium, potassium, lithium	Cwt.	52,619	24,025	784,423	195,718
Potassium carbonate	,,	65,697	84,483	212,902	276,082
Other potassium cpds. (not fertilisers)	,,	56,619	75,876	264,056	344,283
Selenium	Lb.	151,243	110,389	892,409	554,197
Silicon	Tons	4,632	4,012	691,354	659,174
Sodium chlorate	Cwt.	83,291	99,725	254,720	335,785
Sodium phosphate	,,	17,466	3,210	79,195	22,233
Other sodium cpds.	,,	238,802	263,075	926,030	945,335
Inorganic chemicals (nes)		—	—	2,081,916	2,275,009
ORGANIC & OTHERS					
Acids, anhydrides and their salts and esters		—	—	1,481,069	2,102,290
Glycerine	Cwt.	93,453	100,794	703,182	620,063
Menthol	Lb.	72,242	121,747	149,214	251,266
Naphtha, methyl alcohol and alcohols and alcohol mixtures (nes)		—	—	1,777,009	2,421,255
Turpentine	Gall.	643,205	423,969	162,042	113,060
Glycol ethers and esters	Lb.	5,636,307	5,940,408	479,008	512,940
Sodium compounds	Cwt.	83,228	103,298	845,528	1,081,275
Styrene (monomeric)	Gall.	2,605,817	809,246	1,425,923	421,011
Vinyl acetate (monomeric)	Tons	8,524	3,811	1,244,864	444,830
Dyestuffs intermediates	Cwt.	5,483	23,835	376,149	748,209
Organic compounds (nes)		—	—	9,586,312	8,959,735
Synthetic organic dyestuffs and cpds.	Cwt.	26,858	26,790	2,015,072	2,439,437
Sulphur	Tons	277,464	259,942	4,215,775	3,965,030
Mineral phosphates of lime	,,	970,628	885,954	7,166,067	6,916,361
Bonemeal	,,	7,026	6,927	164,828	163,903
Sodium nitrate, natural	,,	15,260	18,394	329,012	392,485
Vitamins		—	—	1,130,667	822,792
Antibiotics		—	—	550,089	739,061
Alkaloids		—	—	741,903	473,800
Basic slag	Tons	49,982	60,249	398,455	496,475
Potassium chloride	Cwt.	8,375,749	7,599,083	6,840,078	6,329,753
Potassium sulphate	,,	188,535	234,377	190,286	231,957
Other fertilisers		—	—	1,191,726	1,324,801
PLASTICS MATERIALS					
Vinyl resins	Cwt.	87,980	123,974	1,271,904	1,598,931
Other synthetic resins	,,	159,228	200,142	2,099,323	2,709,061
Polystyrene	,,	3,377	7,579	41,563	99,512
Other moulding powders	,,	18,935	38,174	344,971	693,544
Sheet, rod, tube, film and foil	,,	89,638	102,277	4,277,789	4,657,361

EXPORTS OF ALL CHEMICALS TO PRINCIPAL MARKETS

	Jan./Sept. 1955	Jan./Sept. 1956	Jan./Sept. 1957
Gold Coast	2,980,288	3,275,317	3,894,391
Nigeria	3,819,762	4,099,624	3,790,063
Union of South Africa	8,761,303	8,985,180	9,563,248
Rhodesia and Nyasaland	1,722,787	1,759,280	2,179,293
India	12,306,528	13,859,493	13,848,270
Pakistan	3,282,068	2,938,058	2,644,408
Singapore	2,955,150	3,353,695	3,174,223
Federation of Malaya	2,602,883	2,709,958	2,963,065
Ceylon	2,013,560	1,747,383	2,566,477
Hong Kong	2,383,525	2,614,483	3,409,045
Australia	14,312,267	13,204,315	15,991,250
New Zealand	5,856,977	5,532,229	6,303,420
Canada	5,340,624	5,887,170	6,083,314
Irish Republic	5,035,181	5,051,347	4,974,892
Sweden	4,437,966	4,693,830	5,412,076
Norway	2,492,988	2,631,384	3,013,033
Denmark	2,888,811	3,291,536	3,519,274
Western Germany	4,080,104	4,548,319	6,379,392
Netherlands	5,699,430	6,548,413	7,544,436
Belgium	3,965,493	4,258,516	4,950,851
France	5,182,301	5,334,919	6,871,912
Switzerland	1,921,640	2,243,418	2,431,416
Portugal	1,358,147	1,653,713	2,062,272
Italy	4,533,414	6,207,623	6,646,532
Netherlands Antilles	2,194,818	1,961,288	2,395,537
Iraq	1,554,783	1,793,988	2,168,387
Iran	1,360,422	1,386,238	2,524,302
Burma	1,935,212	1,874,633	3,425,829
Brazil	182,884	1,703,057	2,194,259
Argentine Republic	3,718,358	2,309,354	4,007,532
United States of America	5,719,625	6,616,456	5,620,113
Total for all Countries	**172,256,211**	**179,812,457**	**200,937,893**

NEW PATENTS

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Specifications filed in connection with the acceptances in the following list will be open to public inspection on the dates shown. Opposition to the grant of a patent on any of the applications listed may be lodged by filing patents form 12 at any time within the prescribed period

ACCEPTANCES

Open to public inspection on 4 December

Preparing a gasoline reforming catalyst. Grace & Co., W. R. **787 275**

Preparation of cation-exchange resins. Rohm & Haas Co. **787 358**

Manufacture of combustible gas. Humphreys & Glasgow, Ltd. **787 134**

Lubricants. UK Atomic Energy Authority. **787 359**

Diquaternary compounds and the manufacture thereof. Wellcome Foundation, Ltd. [Cognate application 1957.] **787 279**

Aromatic diazooxide-sulphonamides. General Aniline & Film Corp. **787 360**

Manufacture of dibasic alkaline-earth metal phosphates and luminescent powders containing such phosphates. Ateliers de Constructions Electriques de Charleroi. **787 361**

Ampoules. British Xylonite Co., Ltd., Senior, H., and Trotter, P. A. **787 090**

Cement treating composition. Continental Oil Co. **787 363**

Manufacture of isonicotinyl hydrazide. Distillers Co., Ltd. **787 282**

Colouring matters of the anthraquinone series and process of colouring therewith. Imperial Chemical Industries, Ltd. **787 284**

Production of phenols. Imperial Chemical Industries, Ltd. **787 135**

Antiseptic. Smith & Nephew, Ltd., T. J. **787 139**

Introduction of fine substances into baths of molten steel. Rheinische Kalksteinwerke Ges. **787 098**

Controlling deposition of salts in tube systems of steam generators. Sulzer Freres Soc. Anon. **787 099 787 103 787 143**

Production of phosphate coatings on metal. Pyrene Co., Ltd. [Addition to 718 362.] **787 291**

Process and apparatus for heat-treating fluidised solids. Dorr-Oliver, Inc. **787 292**

Halo-carboxysilanes and halocarboxysiloxanes. Midland Silicones, Ltd. **787 209**

Tricyclohexyl borates. Borax Consolidated, Ltd. [Addition to 765 515.] **787 146**

Epoxidised polycyclopentadienes. Food Machinery & Chemical Corp. **787 293**

Preparing cold swelling starch products. Naamlooze Vennootschap W. A. Scholten's Chemische Fabrieken. **787 153**

Atomising and spraying apparatus. Heizmotoren Ges. **787 294**

Removing impurities from platinum. Universal Oil Products Co. **787 296**

Hydroforming. Esso Research & Engineering Co. **787 297**

Tetracycline by fermentation. Bristol Laboratories, Inc. **787 368**

Quaternary ammonium salts of benzthiazole azo dyestuffs. Geigy AG., J. R. **787 369**

Anticonvulsant pharmaceutical composition. Abbott Laboratories. **787 156**

Anthraquinone dyestuffs and their use. Geigy AG., J. R. **787 299 787 371**

Substituted 1, 2, 3, 4-tetrahydronaphthalenes. Giraudan & Cie Soc. Anon., L. **787 300**

Pretreatment of oxidic iron catalysts. Rheinpreussen AG Fuer Bergbau und Chemie. **787 124**

Terpolymers and compositions containing same. Monsanto Chemical Co. **787 372**

Anti-knock compounds. Ethyl Corp. **787 374**

Polymerisation or copolymerisation of ethylene. Du Pont De Nemours & Co., E. I. **787 375**

Apparatus for use in the atmospheric cooling of heated solid material, in cake, agglomerate or granular form. Kaiser Steel Corp. **787 304**

1, 2-metal complexes of a benzenemonoazo pyrazolene dyestuff. Ciba Ltd. **787 305**

Removal of chlorine from chlorine-water solutions. Hooker Electrochemical Co. **787 306**

Preparation of vulcanised natural or synthetic rubber products. Hercules Powder Co. **787 221**

Production of acrylonitrile. Monsanto Chemical Co. **787 110**

Process and apparatus for washing gases. Soc. Belge Prat-Daniel. **787 120**

Conveying apparatus for pulverulent material. Biel, H. **787 158**

Dust filter, particularly for hot gases or vapours. Klöckner - Humboldt - Deutz AG. **787 376**

Purification of wood pulp. Columbia Cellulose Co. Ltd. **787 307**

Substituted aminopropiophenones. Aktiebolaget Ferrosan. **787 308**

Dyeing natural and synthetic polyamide fibres. Badische Anilin- and Soda-Fabrik AG. **787 378**

Apparatus for utilising detonation waves. Union Carbide Corp. [Addition to 742 458. **787 222**

Halogenated diamino-dihydroxy anthraquinones. Farbenfabriken Bayer AG. **787 379**

Vat dyestuffs of the anthraquinone series and process for their manufacture. Ciba Ltd. **787 311**

Condensation products of haloacetamides. Farbenfabriken Bayer A.G. **787 400**

Thermochemical metal removal. Union Carbide Corp. **787 163**

Acyl hydrazones. Farbenfabriken Bayer AG. **787 164**

Protecting against corrosion of or inhibiting corrosion of iron, aluminium, zinc and their alloys. Henkel and Cie Ges. **787 229**

Antibiotic compositions. Pfizer and Co., Inc., C. **787 316**

N-trichloromethylthio derivatives. Esso Research and Engineering Co. **787 168**

Production of DL-or L iso-propyl-aminomethyl-(3, 4-dihydroxyphenyl)-carbinol-and salts thereof. Cilag Ltd. **787 382**

Stabilisation of 3, 4-dihydro-2-formyl-2H-pyran. Union Carbide Corp. **787 231**

Production of sodium sulphide. Farbenfabriken Bayer AG. **787 172**

Process for treating a secondary alkylbenzene. Standard Oil Co. [Divided out of 787 240.] **787 241**

Open to public inspection on 11 December

Process for froth flotation dressing. Bergwerksverband Zur Verwertung Von Schutzrechten Der Kohlentechnik Ges. **787 630**

Production of artificial filamentary materials. British Celanese Ltd. [Addition to 720 187.] **787 557 787 558**

Manufacture or treatment of artificial filamentary materials. British Celanese Ltd. [Cognate application 28774, divided out of 787 558.] **787 559 787 560 787 561**

Synthesis of urea. Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques. **787 504**

Treatment of platinum catalyst. Esso Research & Engineering Co. **787 575**

Lubricating oil compositions. Esso Research & Engineering Co. **787 459**

Nickel-chromium austenitic alloys. Jessop & Sons Ltd., W. [Addition to 674 021.] **787 636**

Alloys. Jessop & Sons Ltd., W. [Addition to 686 180.] **787 637**

Production of salts of 3-hydroxypropanel-sulphonic acid. Boehme Fettchemie Ges. **787 463**

Manufacture of isopropenyl acetate. Imperial Chemical Industries Ltd., Chatburn, F. B., and Moss, A. A. H. **787 577**

Pharmaceutical compositions. Pfizer & Co., Inc., C. **787 638**

Gas producer plant. Power Jets (Research & Development) Ltd. **787 639**

Manufacture of water-insoluble monoazo-dyestuffs of the tetrazole series. Farbwerke Hoechst AG. **787 582**

Esters. Geigy Co. Ltd. **787 467**

Metallisable azo dyestuffs derived from quinoline. Imperial Chemical Industries Ltd. **787 646**

Treatment of films of polyethylene resins. Celanese Corp. of America. **787 403**

Method of insolubilising artificial filaments, threads, fibres, and the like of regenerated protein. Imperial Chemical Industries Ltd. **787 588**

Fertiliser material. Fisons Ltd. **787 590**

Stilbene compounds. Farbenfabriken Bayer AG. **787 429**

Preparation of titanium nitride. British Titan Products Co. Ltd. **787 516**

Substituted pregnanes and process for their production. Laboratoires Francais de Chimiotherapie. **787 455**

Penicillin salts of organic bases. Allen & Hanburys Ltd. **787 659**

Selenium rectifiers. Siemens-Schuckertwerke AG. **787 661**

Preparation of aminocarbinols. Welcome Foundations Ltd. **787 668**

Manufacture of trimethylene oxide compounds containing hydroxyl groups. Farbenfabriken Bayer AG. **787 406**

Production of artificial filaments. Courtaulds Ltd. **787 407**

Steroid compounds and the preparation thereof. Pfizer & Co., Inc., C. **787 410**

Aetiocholane derivatives. Laboratoires Francais de Chimiotherapie. **787 456**

Adherent synthetic resin coatings on pergamyn and parchment papers. Newby, H. (Chemische Werke Hüls AG). **787 482**

Production of volatile polymerisation products of ethylene. Ziegler, K. **787 438**

Loosening ceramic products from a form. Bühler, Geb. **787 484**

Process and apparatus for the evaporation of heterogeneous liquid mixtures. Rütgerswerke-AG. **787 688**

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Candidates must have at least one of a number of specified qualifications. Examples are Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University degree. Candidates taking their examinations in 1957 may be admitted provisionally. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general a higher standard of qualification will be looked for in the older candidates than in the younger ones.

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